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HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS
AGRICULTURAL COLLEGE.

BULLETIN No. 26.

Strawberries.
Blackberries.
Raspberries.

OCTOBER, 1894.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
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HATCH EXPERIMENT STATION

26-50

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Charles H. Fernald, Ph. D.,	*Entomologist.*
Clarence D. Warner, B. Sc.,	*Meteorologist.*
William M. Shepardson, B. Sc.,	*Assistant Horticulturist.*
Malcolm A. Carpenter, B. Sc.,	*Assistant Horticulturist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Charles P. Lounsbury,	*Assistant Entomologist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,
Amherst, Mass.

Division of Horticulture.

SAMUEL T. MAYNARD.

TESTS OF SMALL FRUITS, 1894.

STRAWBERRIES.

The plants in the experiment plots and also in the field came through the winter with little injury. A light covering of coarse stable manure was spread over the plants just before the ground became frozen, and later, alternate sections were mulched with straw. All came through about equally well.

The warm weather of March and early April started the plants into an early growth, but subsequent cold weather and the dry condition of the soil kept them back so that they did not bloom as much in advance of the average season as was feared. The drouth early in June threatened destruction to the crop, but rains soon after enabled the fruit to mature in good condition.

In some places late frosts cut off some of the early blossoms, but those uninjured came on in good time, and the crop was better in size and quality for this thinning.

In the immediate vicinity of the college a severe hail storm occurred on the 5th of June, which cut the foliage badly and reduced measurably its power to mature the crop.

The first picking was made one week or ten days in advance of the season of 1893. All the varieties were planted on the same kind of soil and were carefully treated in the same way in regard to fertilizer and cultivation. The fruit was picked every day, or every other day, and carefully weighed, the weight being given in the following table. This table also shows by figures or letters the size, color, form, quality, firmness, sex, vigor, amount of winterkilling and date of first and last picking of each variety.

Explanation of Table. *Size;* l large, m medium, s small.
Color; l light, m medium, d dark.
Form; r round, c conical, r c round conical, ir irregular, c f coxcomb form.
Quality; g good, v g very good, m medium, p poor.
Sex; s staminate, p pistillate.

VARIETY.	Sex.	% Winterkilling.	Vigor.	Date of Blooming.	Date of Ripening.	First Picking.	Last Picking.	Yield.		Size.	Form.	Quality.	Firmness.	Color.
								lbs.	ozs.					
Accomac,	s	.04	.40	May 6	June 11	June 13	June 25	4	9	l	c	m	f	m
Alabama,	s	.16	.40	May 3	June 8	June 12	June 25	0	13	s	r	p	f	m
Auburn,	p	.08	.40	May 6	June 10	June 12	June 25	4	4	m	r	m	m	m
Barton's Eclipse,	p	.20	.25	May 3	June 8	June 12	June 25	3	4	m	r	m	f	d
Beaver's No. 3,	s	.20	.40	May 9	June 12	June 14	June 22	0	12	m	r	m	m	m
Beder Wood,	s	.16	.60	Apr. 30	June 2	June 9	July 2	6	6	l	r	g	f	l
Beebe,	s	.28	.50	May 3	June 6	June 11	June 29	3	11	l	r	g	f	m
Belle la Crosse,	s	.08	.75	May 4	June 12	June 15	July 2	3	12	m	c	m	f	m
Belmont,	s	.12	.70	May 7	June 10	June 12	July 2	5	13	l	rc	g	f	d
Beverly,	s	.20	.75	May 4	June 10	June 11	July 2	6	0	l	r	g	vf	d
Boynton,	p	.12	.75	May 2	June 1	June 6	July 2	9	8	s	r	m	f	m
Bubach No. 5,	p	.08	.50	May 4	June 5	June 9	July 2	6	14	l	rcf	g	f	m
Brandywine,	s	.00	.95	May 7	June 10	June 12	July 2	10	5	l	r	g	vf	m
Chas. Downing,	s	.06	.65	May 2	June 7	June 9	July 2	5	11	m	r	vg	f	l
Chairs,	p	.00	.40	Apr. 29	June 1	June 9	June 20	2	5	m	r	g	m	l
Cornelia,	s	.08	.80	May 7	June 11	June 16	July 2	5	8	l	r	m	f	m
Crawford,	p	.04	.70	May 1	May 31	June 6	July 2	10	11	s	r	m	m	l
Crawford's No. 51,	s	.08	.95	May 7	June 10	June 15	July 2	9	4	vl	c	g	m	m
Crescent,	p	.00	.85	May 1	June 1	June 6	July 2	15	3	m	r	g	f	m
Cumberland,	s	.00	.95	May 6	June 11	June 12	July 2	16	4	l	r	g	s	l
Cutter's Seedling,	s	.00	.95	Apr. 30	June 7	June 9	July 2	7	6	s	rc	vg	m	l
Davis No. 2,	s	.16	.50	May 3	June 5	June 9	July 2	2	7	l	r	g	m	l
Dayton,	s	.08	100	May 3	June 4	June 6	July 2	6	2	l	rc	m	s	l
Dew,	s	.00	.40	May 3	June 11	June 16	July 2	3	0	vl	cf	g	f	d
Dutton,	s	.20	.40	May 7	June 8	June 13	July 2	2	9	l	rc	g	m	m
Edgar Queen,	p	.04	·90	May 6	June 5	June 6	June 29	11	7	m	rc	g	f	m
Enhance,	s	.00	100	May 7	June 10	June 12	June 29	18	11	l	r	m	f	d
Epping,	p	.00	100	May 6	June 8	June 12	July 2	11	11	l	rc	g	m	l
E. P. Roe,	s	.04	.65	May 7	June 10	June 14	July 2	3	3	m	rc	m	s	l
Felton,	s	.32	.60	May 5	June 9	June 11	June 27	3	4	l	rc	g	m	d
Florence,	s	.28	.25	May 7	June 9	June 11	June 29	2	15	m	r	g	m	d
Gandy,	s	.08	.30	May 9	June 10	June 12	July 2	3	0		rc	vg	f	m
Gen. Putnam,	p	.16	.65	Apr. 29	June 4	June 9	June 23	1	9	l	r	m	s	m
Gillespie,	s	.00	.65	May 3	June 9	June 11	June 29	3	12	l	c	g	m	l
Glendale,	s	.04	.55	May 6	June 10	June 13	July 2	7	6	l	rc	g	vf	d
Golden Defiance,	p	.12	.75	May 9	June 10	June 12	July 2	18	8	l	r	g	f	m
Gov. Hoard,	s	.12	.70	May 3	June 5	June 11	July 2	5	9	l	rc	m	f	m
Greenville,	p	.00	.98	May 3	June 9	June 11	July 2	18	13	l	rc	m	m	m
Haverland,	p	.00	.85	May 1	May 31	June 6	July 2	16	11	l	c	g	f	m
Hinsmore,	s	.00	.70	May 3	June 11	June 12	June 20	5	0	l	r	g	f	m
Howard's No. 10,	s	.08	.40	May 1	June 4	June 6	June 22	4	11	l	r	m	m	l
Howard's No. 13,	s	.08	.50	May 4	June 3	June 6	June 27	7	12	l	r	m	m	l
Howard's No. 20,	s	.08	.35	May 5	June 9	June 11	June 29	2	11	l	r	g	f	m
Howard's No. 28,	p	.12	.45	May 9	June 10	June 11	July 2	7	4	l	r	g	f	m
Howard's No. 34,	p	.00	.65	May 7	June 8	June 11	July 2	12	2	l	rc	g	f	d
Howard's No. 39,	s	.00	.50	May 3	June 11	June 13	July 2	10	0	l	r	g	f	l
Howard's No. 41,	p	.00	.70	May 1	June 7	June 9	July 2	9	11	l	rc	m	f	d
Howard's No. 53,	s	.08	.70	May 3	June 8	June 9	June 29	5	4	m	r	g	m	m
Howard's No. 76,	p	.16	.35	May 6	June 11	June 12	June 29	2	11	m	rc	m	m	m
Howard's No. 116,	s	.08	.30	May 7	June 9	June 12	June 29	2	2	m	r	m	m	l

VARIETY.	Sex.	% Winterkilling.	Vigor.	Date of Blooming.	Date of Ripening.	First Picking.	Last Picking.	Yield.		Size.	Form.	Quality.	Firmness.	Color.
								lbs.	ozs.					
Howard's No. 117, ...	s	.04	.70	May 7	June 9	June 12	July 2	11	4	l	rc	m	f	m
Howard's No. 122, ...	s	.08	.75	May 9	June 9	June 13	July 2	7	13	l	rc	m	m	m
Howard's No. 145, ...	s	.12	.50	May 1	May 31	June 6	June 26	2	14	m	rc	m	f	d
Howard's No. 149, ...	p	.04	.55	May 2	June 4	June 6	July 2	9	0	l	r	p	s	l
Howard's No. 157, ...	s	.04	.30	May 2	June 5	June 6	June 27	3	5	m	r	p	m	m
Howard's No. 501, ...	s	.08	.20	May 3	June 10	June 12	July 2	4	6	m	r	g	f	m
Howard's No. 601, ...	s	.00	.60	May 2	June 2	June 6	July 2	12	0	m	rc	m	f	m
Howard's No. 605, ...	s	.08	.35	May 2	June 7	June 9	June 25	2	0	l	r	g	m	d
Iowa Beauty, ...	s	.12	.74	May 2	June 4	June 6	June 29	9	0		r	g	f	d
Jay Gould, ...	p	.12	.65	May 6	June 4	June 6	June 29	4	11	m	r	g	f	d
Jucunda Improved, ..	s	.04	.65	May 8	June 8	June 11	June 29	6	1	l	r	g	f	d
Lady Rusk, ...	p	.08	.55	May 3	June 6	June 11	June 26	1	12	m	r	m	f	d
Laxton's Commander,	s	.08	.50	May 2	June 6	June 9	July 2	2	1	l	c	g	f	m
Leader, ...	s	.00	.70	May 1	June 4	June 6	June 29	8	14	l	rc	vg	f	d
Loudon, ...	s	.08	.65	May 1	June 3	June 6	June 27	3	13	m	rc	m	f	m
Lovett's Early, ...	s	.00	.70	May 1	May 30	June 6	July 2	12	13	l	rc	g	f	d
Luther, ...	s	.00	.25	Apr. 30	June 3	June 6	June 23	2	1	m	c	m	m	m
Marshall, ...	s	.00	.80	May 2	June 5	June 9	June 29	13	5	v l	r	vg	f	d
Martha, ...	p	.04	.70	May 3	June 5	June 6	July 2	8	8	l	r	p	f	d
Michel's Early, ...	s	.00	.75	Apr. 28	May 28	June 6	June 26	3	11	l	r	g	f	m
Middlefield, ...	p	.12	.65	May 3	June 4	June 9	June 29	7	2	l	r	g	f	m
Miller's Seedling, ...	s	.00	.90	May 7	June 10	June 11	June 29	1	2	m	r	m	f	m
Miner's Prolific, ...	s	.16	.10	May 6	June 8	June 11	June 25	3	6	m	rc	g	vf	d
Moore, ...	s	.08	.75	May 6	June 8	June 11	June 25	1	14	l	r	g	f	m
Mrs. Cleveland, ...	p	.04	.50	May 1	June 8	June 9	June 25	4	3	m	r	g	f	m
Mt. Holyoke, ...	s	.12	.40	Apr. 30	June 1	June 6	June 25	3	11	m	cf	g	f	m
Muskingum, ...	s	.04	.75	Apr. 30	June 5	June 6	June 27	4	8	m	r	g	f	d
Norwood, ...	s	.08	.35	Apr. 30	June 2	June 6	June 29	5	12	m	rc	p	m	m
Ohio Centennial, ...	s	.00	.50	May 3	June 8	June 11	July 2	8	14	l	rc	g	m	l
Oliver, ...	s	.00	100	May 7	June 11	June 15	July 2	12	11	l	rc	g	vf	d
Oregon, ...	s	.30	.10	Apr. 29	June 8	June 11	June 25	1	11	s	r	p	m	l
Our Choice, ...	p	.04	.35	May 4	June 8	June 11	June 25	3	11	l	r	m	f	l
Pacific, ...	p	.08	.35	May 3	June 3	June 6	June 29	4	4	l	rc	m	f	d
Parker Earle, ...	s	.00	.60	May 6	June 8	June 11	June 29	12	5	l	c	vg	f	m
Parmenter's Seedling,	p	.12	.40	May 1	June 8	June 11	June 29	4	7	s	rc	p	f	d
Phillips' Seedling, ...	s	.00	.50	May 2	May 31	June 9	July 2	6	9	l	rc	m	m	m
Pioneer, ...	s	.04	.40	May 1	June 4	June 6	June 27	3	6	m	r	g	f	l
Pomona, ...	s	.04	.80	May 2	June 5	June 9	June 25	3	11	m	r	g	f	l
Princess, ...	p	.16	.40	May 4	June 4	June 6	June 25	2	8	s	r	m	f	l
Regina, ...	p	.00	.60	May 7	June 12	June 14	July 2	5	8	m	rc	m	f	d
Rheil's No. 1, ...	p	.04	.45	May 2	May 30	June 6	June 27	7	8	s	r	p	m	l
Sadie, ...	p	.08	.60	Apr. 29	May 29	June 6	June 27	6	6	s	r	p	f	l
Sam, ...	s	.04	.59	May 3	May 31	June 9	June 22	1	11	m	r	g	f	d
Sandoval, ...	s	.20	.50	May 1	June 2	June 6	June 27	2	5	l	r	m	f	m
Saunders, ...	s	.20	.50	May 6	June 2	June 6	June 27	5	2	l	r	m	f	d
Seedling No. 24, ...	s	.08	.60	May 1	June 6	June 9	June 27	6	2	l	r	m	m	d
Seedling No. 45, ...	s	.00	.60	May 1	June 7	June 9	June 26	6	8	m	r	g	f	m
Seedling No. 48, ...	s	.00	.90	May 3	June 7	June 9	June 29	11	6	v l	cf	m	m	l
Sharpless, ...	s	.00	.80	May 7	June 7	June 11	July 2	10	2	l	cf	vg	f	l
Shaw, ...	s	.00	.70	May 5	June 7	June 11	June 25	5	2	l	rcf	g	f	l

VARIETY.	Sex.	% Winterkilling.	Vigor.	Date of Blooming.	Date of Ripening.	First Picking.	Last Picking.	Yield.		Size.	Form.	Quality.	Firmness.	Color.
								lbs.	ozs.					
Shurtleff Seedling, ...	s	.00	.50	May 3	June 8	June 9	June 26	1	11	m	c	m	m	l
Shuster's Gem, ...	s	.00	.50	May 3	June 7	June 9	June 25	5	4	l	r	m	m	m
Smeltzer's Early No. 2,	s	.00	.45	May 1	June 1	June 6	June 25	1	6	m	c	p	f	m
Southard, ...	s	.00	.45	May 1	June 1	June 6	June 25	2	0	l	r	g	f	m
Standard, ...	p	.00	.45	May 3	June 8	June 9	July 2	3	13	l	r	m	f	l
Stayman's No. 1, ...	p	.08	.70	May 5	June 1	June 6	July 2	4	12	l	c	m	f	m
Sterling, ...	p	.00	.50	May 3	June 8	June 11	June 23	0	14	m	r	g	f	d
Stevens, ...	s	.00	.40	May 1	May 28	June 6	June 25	1	3	s	rc	p	f	l
Sunnyside, ...	p	.00	.50	May 2	May 30	June 9	June 25	2	8	m	c	m	f	l
Swindle, ...	p	.00	.50	May 1	June 4	June 9	July 2	3	12	l	r	m	f	d
Timbrell, ...	p	.00	.70	May 2	June 9	June 12	July 2	10	6	l	r	vg	f	d
Townsend's No. 20, ..	p	.00	.50	May 8	June 4	June 9	June 23	2	0	l	r	g	f	d
Triumph, ...	s	.00	.30	May 3	June 12	June 14	June 25	2	8	l	r	g	f	d
Van Deman, ...	s	.04	.40	May 2	May 28	June 6	June 23	2	1	l	r	g	f	d
Waldron, ...	p	.08	.30	May 1	June 5	June 6	June 25	2	6	m	c	m	f	m
Walton, ...	p	.08	.50	May 3	June 5	June 9	June 23	1	3	m	c	m	f	m
Warfield, ...	p	.04	.70	May 1	May 29	June 6	June 23	4	8	l	c	g	f	d
Westbrook, ...	p	.08	.58	Apr. 30	May 28	June 6	June 18	0	3	s	c	m	m	m
West Lawn, ...	p	.12	.40	May 12	June 8	June 6	June 20	0	12	m	c	m	f	l
Williams, ...	s	.08	.75	May 7	June 7	June 11	July 2	4	0	l	c	m	f	d
Wilson, ...	s	.12	.20	Apr. 29	June 1	June 9	June 20	4	5	s	r	m	f	d
Wolverton, ...	s	.12	.70	May 7	June 8	June 12	July 2	10	11	l	rc	m	f	d
Yale, ...	s	.00	.50	May 7	June 12	June 15	June 22	0	12	m	c	m	f	l
Yankee Doodle, ...	p	.00	.50	May 6	June 3	June 6	June 26	6	8	l	rc	g	m	l

VARIETIES DESERVING MENTION.

Of the varieties that show the greatest merits the following are worthy of mention :

Belmont. While this variety continues to do well on new soil and under high cultivation, it is not one that can be profitably grown under the ordinary treatment given by the average grower.

Beverly. This appears to be identical with the Miner's Prolific, but possibly may be a little more vigorous and productive than that variety generally proves. On new soil, with an abundance of manure it yields a heavy crop of high flavored berries, which are however rather soft for shipping.

Bubach No. 5. This has proved one of the most profitable market berries in many localities, but is soft and requires careful treatment. The plants should not be allowed to run too thickly in the row, for if the fruit is much shaded it becomes of light color and often, in moist weather, decays before fully ripe.

Brandywine. This much praised variety made a fine growth, but did not yield as much fruit as it promised at the time of blooming. Under other conditions its yield may be more in proportion to the growth of the plants.

Crescent. This has hardly been equalled by any of the newer varieties in vigor of plant and yield of fruit. Although still largely grown for market, its poor quality and small size should cause it to be discarded for some variety producing larger fruit of better quality.

Cumberland. After many years, this is again on trial and compares very favorably with many of the newer kinds. Few varieties grow with greater vigor or produce more fruit, but the berry is too soft for long shipment. For a local market it will still be profitable.

Lovett's. Although not ripening as early as many other varieties, it blossoms early and makes an excellent fertilizer for such kinds as Bubach, Haverland, Greenville and other early pistillate varieties, besides producing a large crop of fruit of fair size and very good quality. It will supply the place filled by the Beder Wood, Michel's Early and Shuster's Gem, which in the past have been used for this purpose but which should be discarded on account of rust and small size.

Enhance. This vigorous variety has done better the past season than ever before and may prove profitable.

Golden Defiance. Although this has been grown on the college grounds for more than fifteen years, it has retained its vigor, and proves the most productive very late variety that has been fully tested. The berry is large, round, and perfect in form, of good color and fair quality, and is especially valuable for local markets.

Greenville. For vigor of plant, productiveness and good size of berry, this has proved one of the best. In quality, it is below the average, but will probably be profitable.

Haverland. If properly grown, this variety is one of the best for market or home use. If the plants are not allowed to grow too closely the fruit is of good size and color and of fine quality. When allowed to run in too closely matted rows the berries are of light color and too soft for long shipment.

Marshall. From the test made in a small plot we conclude that there is no variety yet introduced that shows so much merit. There is however a tendency to leaf blight which, if it increases, may render it of little value. The plant is remarkably vigorous, but it makes comparatively few runners. The berries are very large, of perfect form and rich dark color. The quality is of the best and the fruit ripens early.

Timbrell. This variety is unquestionably of better quality than any thus far tested. Owing to the ravages of the larvae of the June Beetle, the yield of this plot was much below what would be the average under more favorable conditions. It is of good size and perfect form, but its color is not such as to make it attractive. Under more favorable conditions it may be of better color and yield a larger crop, in which case it would be among the best for market and home use.

Parker Earle. No variety shows a more vigorous growth of plant or makes more show of fruit, but it seems to lack the vigor to ripen its fruit under some conditions.

INSECTS AND FUNGOUS DISEASES.

The larvae of the June Beetle caused serious injury to some varieties and after they had become located in the bed there seemed to be no remedy, but to dig out the worms at the first indication of their presence.

Fungous diseases. The leaf blight appeared in such abundance upon varieties like the Beder Wood and some others as to render the fruit small and of little value.

The spraying with the Bordeaux mixture did not wholly prevent its ravages, though some improvement was seen where it was used. During a few hot, moist days, in early June and again in September, the leaves of a few varieties were destroyed by something that appeared like the "damping off" fungus or some bacterial disease. The leaves decayed in a very short time, frequently in two or three days. The same disease apparently has occurred in other sections of the state and we hope by further investigation to determine more definitely the cause and suggest some remedy.

BLACKBERRIES.

The blackberry crop the past season was one of the best for many years. The table shows the results of the trial of those varieties which fruited sufficiently to form a basis for a report. Each variety was planted in a row which included light, medium and heavy soil, so that a very fair trial was made of each variety in the different kinds of soil. Every other three rows were bent down and the tips covered with soil to test the value of winter protection. The results are shown in the first columns of the table. All the new varieties obtainable have been planted in the station plots, but none of them have fruited sufficiently to warrant a report upon their value.

The winterkilling and amount of disease found on each variety are given in per cents. The letters used to designate size, quality and firmness are the same as used in the table of strawberries.

VARIETY.	Winter-killing.		Date of Blooming.	Date of Ripening.	Disease.	Yield from 50 plants.	Quality.	Firmness.	Size.
	Covered.	Not Cover'd							
						Qts.			
Agawam,	.00	.00	May 23	July 12	.20	65.0	v. g.	m.	l.
Early King,	.00	.05	June 5	July 7	.10	10.0	p.	f.	l.
Erie,	.00	.33	June 5	July 18	.10	20.0	p.	f.	l.
Fred,	.00	.18	May 31	July 22	.05	7.5	p.	f.	m.
Lucretia, (Dewberry,)	.00	.85	May 30	July 6	.00	6.5	g.	s.	v.l.
Minnewaski,	.00	.15	May 31	July 20	.00	9.0	m.	f.	l.
Snyder,	.00	.00	May 25	July 16	.15	41.0	v. g.	f.	l.
Stone's Hardy,	.00	.05	May 31	July 21	.00	7.0	p.	f.	l.
Taylor,	.00	.02	May 29	July 20	.05	97.0	v. g.	f.	l.
Wachusett,	.00	.00	May 25	July 16	.20	41.0	g.	f.	s.
Western Triumph,	.00	.02	June 5	July 21	.00	4.0	p.	f.	l.
Wilson,	.00	.00	June 4	July 18	.00	23.0	g.	f.	l.

Of the varieties given in the above table only the Agawam, Snyder and Taylor can be recommended for profit.

The Agawam is the earliest of the three and has generally been free from disease and very productive, but in one or two cases it has been reported as unproductive, and during the past season, has, in several places, been injured by a fungous disease attacking the leaves, somewhat similar to the yellow blackberry rust so common on the Wachusett and some of the blackcap varieties of raspberry. This disease is probably more nearly related to the rose rust or Phragmidium.

It has been discovered on this and many other varieties in the college plots, on the Agawam in Northboro, Mass. and also on the same variety in Amesbury, Mass. Attacking the plants in the late summer and autumn, the canes probably do not mature perfectly, and this may be the cause of their failure to produce good crops of fruit. The disease will be carefully investigated during the winter and suggestions made as to remedies before the season of 1895.

Snyder. This is one of the most hardy, vigorous and productive varieties in cultivation, but the berries turn red so soon after picking that they are unsalable after standing in the boxes more than one day. For a local market it is very valuable.

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*Prof. B. T. Galloway of the Mycological Division of the Dept. of Agriculture reports this fungus as *Chrysomyxa albida*, or fall raspberry rust.

Taylor. This is more hardy and more productive than either of the two last mentioned varieties, but it ripens from one week to ten days later, when prices are often very low, so that frequently it is not as profitable as the earlier kinds. In quality it is one of the best. For home use nothing has thus far been introduced equal to it.

Erie. We are again obliged to report this variety as not hardy enough to be of much value in New England.

RED RASPBERRIES.

The raspberry crop though not large, on account of the drouth, was very good and as no rain fell during the time of ripening it was harvested without any loss.

The varieties reported upon were grown in rows alternating with blackberry or blackcap plants, parts of each row being grown in light, medium and heavy soils.

Application of fungicides (copper sulphate solution before the leaves started and Bordeaux mixture before the blossoms opened) was made, and little of the anthracnose or the yellow rust appeared.

During the fall the yellow leaf rust described under the blackberry appeared on some varieties, but not in sufficient quantity to do serious injury.

The effect of covering to protect from winterkilling is shown in columns 1 and 2.

Figures, Letters, etc., the same as in preceding tables.

VARIETY.	Winter-killing.		Date of Blooming.	Date of Ripening.	Disease.	Yield from 50 Plants.	Quality.	Firmness.	Size.
	Covered.	Not Cover'd							
						Qts.			
Belle de Fontaine,	.00	.02	June 4	June 30	.00	12.8	p.	f.	l.
Brandywine.	.00	.04	June 4	June 29	.00	15.0	g.	m.	s.
Crimson Beauty,	.00	.05	June 7	June 30	.00	15.0	g.	s.	s.
Cuthbert,	.00	.05	June 5	June 30	.00	9.5	m.	f,	l.
Golden Queen,	.00	.20	June 5	June 30	.00	55.0	m.	m.	l.
Gladstone,	.05	.50	May 30	June 30	.10	10.4	p.	s.	s.
Hansel,	.00	.08	May 28	June 25	.20	57.0	v. g.	s.	m.
Herstine,	.00	.08	June 2	June 30	.00	10.0	g.	s.	m.
Highland Hardy,	.00	.05	June 3	June 31	.00	14.0	v. g.	f.	s.
Marlboro,	.00	.05	May 30	June 28	.20	43.5	m.	f.	l.
Naomia,	.00	.50	June 5	July 5	.10	13.1	g.	m.	l.
Rancocas,	.00	.05	May 28	June 23	.00	32.0	m.	m.	s.
Scarlet Gem,	.00	.10	May 31	June 24	.00	8.0	m.	s.	s.
Stayman's No. 5,	.00	.30	May 31	June 30	.00	10.0	p.	f.	m.
Thompson's Early Prolific,	.00	.05	May 31	June 23	.00	38.0	g.	f.	m.
Thompson's Pride,	.00	.02	May 28	June 20	.00	44.0	g.	f.	m.
Victor,	.00	.33	June 2	June 28	.00	32.0	m.	s.	l.
White Mountain,	.00	.33	June 6	June 30	.00	7.0	m.	s.	m.

No new varieties have been tested that can be recommended above the old standard sorts, the Cuthbert, Marlboro and Hansel. A careful trial, however, is advised of Thompson's Early Prolific, Stayman's No. 5 and Victor.

BLACK-CAP RASPBERRIES.

As with the red raspberry, the Blackcaps matured early, producing a fair crop and little or no disease prevailed.

The table gives the result of the trial of varieties.

Figures, letters and dates have the same significanee as in the table of blackberries.

VARIETY.	Winterkilling.	Date of Blooming.	Date of Ripening.	Disease.	Yield from 50 Plants. Qts.	Quality.	Firmness.	Size.
Ada,	.10	June 2	July 4	.00	14.0	v. p.	f.	s.
Brackett's Seedling,	.10	May 30	July 1	.00	24.5	g.	f.	v. l.
Carman,	.18	May 30	June 26	.10	29.0	g.	f.	l.
Cluster,	.05	May 27	June 26	.00	34.0	p.	m.	l.
Columbian,	.20	June 2	June 31	.00	50.0	m.	f.	l.
Corinth,	.05	June 1	July 2	.05	45.8	m.	f.	l.
Crawford,	.40	May 31	July 5	.10	11.0	m.	f.	m.
Cromwell,	.25	May 26	June 23	.40	24.0	g.	m.	m.
Earhart,	.10	May 26	June 26	.20	15.3	p.	f.	m.
Hilborn,	.05	May 30	June 30	.00	95.0	g.	f.	l.
Kansas,	.08	May 27	June 28	.08	37.5	g.	f.	v. l.
Lovett,	.10	May 29	June 27	.00	42.3	g.	f.	l.
Nemeha,	.33	May 31	July 1	.25	10.0	m.	f.	l.
Ohio,	.12	May 31	July 1	.00	75.0	v. g.	f.	l.
Older,	.15	May 29	June 29	.00	33.6	g.	m.	l.
Palmer,	.03	May 26	June 26	.10	14.0	g.	f.	m.
Progress,	.05	June 2	June 26	.50	24.0	v. g.	f.	m.
Smith's Prolific,	.12	May 31	June 29	.05	32.6	m.	f.	l.
Souhegan,	.15	May 25	June 26	.04	40.0	g.	f.	m.
Springfield,	.05	May 25	June 24	.25	12.5	p.	f.	s.

Spraying was carefully followed up for the destruction of the anthracnose or spot disease of the canes which has been so injurious several seasons and most of the varieties were entirely free from it. The Cromwell which was so promising before this disease appeared has regained something of its original vigor and possibly, by careful treatment, may prove as valuable here as it is reported to be in some other localities.

The following varieties showing the greatest value we give in the order of their time of ripening: Souhegan, Lovett, Kansas, Hilborn and Ohio.

The Columbian is a Purple cap, resembling the Schaffer in color and growth, more firm and sweet, but not so good in quality. If it proves more hardy than the latter it will be valuable for home use and canning, but is of too dark color to sell well.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 27.

HISTORY OF TUBERCULOSIS IN COLLEGE HERD.
USE OF TUBERCULIN IN DIAGNOSIS.
OUTBREAK OF BOVINE RABIES.
POISONING OF CATTLE BY NITRATE OF SODA.

DECEMBER, 1894.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE
1895.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Charles H. Fernald, Ph. D.,	*Entomologist.*
Clarence D. Warner, B. Sc.,	*Meteorologist.*
William M. Shepardson, B. Sc.,	*Assistant Horticulturist.*
Malcolm A. Carpenter, B. Sc.,	*Assistant Horticulturist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Charles P. Lounsbury, B. Sc.	*Assistant Entomologist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,
Amherst, Mass.

TUBERCULOSIS AND TUBERCULIN

AT THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JAMES B. PAIGE, V. S.

In January, 1889, there was issued from this station a bulletin prepared by Prof. C. H. Fernald upon the subject of Tuberculosis. It treated of the general characteristics of the disease, its causes, history, distribution, symptoms and prevention. The following year one was prepared for the station by Harold C. Ernst, M. D., of Boston, upon the subject of "How far may a cow be tuberculous before the milk becomes dangerous as an article of food?"

At that time, the public knew nothing of the use of Tuberculin as a cure for consumption in persons or as a diagnostic of tuberculosis in cattle.

Within the past two years tuberculin has come into general use in the detection of this disease in cattle and while much has appeared in the agricultural and other newspapers of the country, and in the experiment station bulletins, upon its use for this purpose, to our knowledge nothing but newspaper articles have in this state been given to the public.

While in most instances these articles have been favorable to its employment, in some cases they have denounced it, claiming it to be unreliable in the diagnosis of tuberculosis. This being the case, it was thought advisable to publish the facts as they appeared in connection with the existence of tuberculosis and the use of tuberculin in the Massachusetts Agricultural College herd.

All reference to the nature, causes, symptoms and post-mortem appearances of tuberculosis, together with the infectiousness of the milk of tuberculous cows has been purposely omitted in this bulletin as they have been discussed in previous bulletins of the station and in a paper published in the college catalogue for 1892.*

Considering the number of animals in the college herd tested with tuberculin and the autopsies made,it was thought that certain reliable conclusions could be drawn without reviewing the work of others upon this subject; consequently we shall confine ourselves to the history of the herd, the tests with tuberculin, the results of the autopsies and the conclusions to be drawn from a careful study of the subject.

DESCRIPTION OF THE STABLE AND HISTORY OF THE HERD.

In 1869 there was built on the college farm the barn recently destroyed by fire. In the college report for the following year it is described in part as follows: " It is a substantial but plain structure of wood, upon a granite foundation. The cellar for manure extends under the entire main building, and is one hundred feet in length, fifty feet wide, and ten feet deep. It is accessible with teams at the west end by two nearly level drive-ways twelve feet in width, and is well lighted and ventilated by windows on the north and south sides. The lower story immediately over the cellar is eight feet high in the clear and is well lighted by windows on the north, west and south. Ventilation is secured by flues in each corner which extend to the roof, and by the upper sashes of the windows which are hung with weights. On the east end of this floor is a room for roots. . . .

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* A limited number of copies are now in the hands of the Director of the station for distribution.

The stone wall at the east end of the cellar is carried up eighteen feet to support the embankment made for the drive-way into the upper story and thus secures the roots from frost. The remainder of the lower story is occupied by stalls for cattle. The bulls are kept in box-stalls extending across the west end of the stable which are twelve by ten feet; the cows are secured by stanchions upon platforms four and one-half feet wide; the rest of the stock are fastened with chains. There are four rows of stalls running across the barn (north and south between windows).

The three outside doors of this floor open on the south side of the barn into a yard one hundred by seventy-five feet. This is sheltered on the west by an ell containing a sheep-pen and cattle-shed." The main entrance to the upper floor was at the east end with an exit at the west.

In 1870 the ell on the west side of the yard was destroyed by a gale of wind. A year later this was replaced by a new building, with an addition two stories high which extended across the south side of the yard. At this time the east side of the yard was enclosed with a tight board fence, five feet in height, which later on was removed to make room for an engine-room and horse-barn, both two stories high.

Some few years since,the building extending across the south side of the yard was removed and a board fence put in its place. In 1887 the cellar was made water tight by cementing the bottom. With but few alterations this stable remained until destroyed by fire in June, of 1894.

This description has been given to show that the building was a model for a stable at the time of its construction when nothing was to be feared from tuberculosis. And if there is taken into consideration only the economical use of space, storage of crops, and ease of caring for the animals, it was a model; but it was not a suitable building from a sanitary point of view for the stabling of animals, but one which offered favorable conditions for the spread of such a disease as tuberculosis.

The cellar was large, for the storage of manure, and water tight to prevent loss of fertilizing material by the escape of the urine. While the report says "was well lighted and ventilated" the only openings were the doors and two or three small windows on the north and south sides which were always tightly closed in winter when the stock was in the stable above and the needs of ventilation were greatest. The ventilating shafts were constructed after the plan in *vogue* at that time, but now known to be quite useless for purifying the air, being so long and sinuous that the air did not circulate in them at all, except under very favorable conditions, and these conditions rarely existed when the needs of the animals for exchange of air were the greatest.

The portion of the building occupied by animals was over the cellar and directly beneath the part used for the storage of fodder. There were scuttles in the floor, through which the excrement was dropped into the cellar, and openings in the ceiling connecting the stable with the part above used for storage purposes. The openings in the ceiling served as chutes through which the hay, etc., was carried below. This arrangement was not conducive to the maintenance of good health, for with insufficient ventilation of both cellar and stable, the gases generated in the cellar from the decomposition of the excrement passed through the openings in the floor to the part occupied by the cattle and from there with other impurities from the animals themselves to the building above, used for storage purposes. In consequence of this the animals were, when in the stable surrounded by an atmosphere filled with the noxious gases coming from their decomposing excrement and their own bodies, while the fodder above soon became contaminated with these same impurities.

The mangers in this stable, from a sanitary point of view, were very objectionable. They were box-like in shape with high fronts and with no provision for proper cleaning. They presented a large amount of surface and being constructed of board there were many open joints, cracks and corners not easily reached, in which food collected.

The cracks and crevices about the mangers as well as in the floors, walls and ceiling, made excellent places for the lodgment of germladen dust, which could in no way be removed nor rendered harmless by the use of disinfecting fluids or washes.

The general arrangement and the relation to adjoining buildings were bad. Extending east and west with main openings to the part above in the ends, reached in the one case by an elevated road-way built of earth and in the other by a trestle-like structure, the construction of a high wall was necessitated as mentioned in the reference to the root cellar. All of the windows with one or two exceptions were on the north and south sides. These with the doors on the south side served for the admission of both light and air. As before mentioned the door on the south side opened into a yard one hundred by seventy-five feet which at first was sheltered on the west side by a building used for sheep and cattle and which was replaced after its destruction by wind, by one with an addition two stories in height extending entirely across the south side of the yard. At a still later period the yard was nearly enclosed on the east side by a two-story boiler room and horse-stable. For a greater part of the time this small yard on the south side was almost wholly enclosed by buildings two stories high.

As the windows on the north, and the doors and windows on the south side were used for the admission of light and air, it is easily seen that neither could be properly supplied on account of the construction and arrangement of the several buildings. The light from the north must have been deficient during the short days of winter, while that from the east, west and south, was almost wholly excluded except for a short time during the middle of the day. The heat produced in the stable filled with animals, by the direct rays of the sun at mid-day, was soon followed by a rapidly lowering temperature as soon as the sunshine was shut off by the adjoining buildings; this necessarily caused sudden variation of temperature.

The temperature of such a stable in winter would be low from a little past noon until nearly noon of the following day and during the middle of the day might be uncomfortably warm for the occupants. Such sudden changes should if possible be avoided.

Again, direct sunlight should be admitted into all buildings occupied by animals in order to get the benefits to be derived from its germicidal action.

It is much better to locate and construct stables so that the occupants will get the benefits of the morning and afternoon sun than to so place them that the sun will shine into them only during the middle of the day; for stables that can be kept comfortable without the use of artificial heat during the morning and afternoon will certainly be kept so at noonday by the aid of sunshine. Under these conditions the sudden fluctuations in temperature which are so trying to animals do not occur.

This stable being poorly arranged for proper lighting was equally so for proper ventilation, which is fully as necessary for the preservation of the health of cattle.

The windows were the same pattern as ordinary house windows. The upper sash was hung with weights so that it might be dropped at the top for the admission of fresh and the escape of impure air.

It has been demonstrated repeatedly that such an opening does not serve as a suitable inlet or outlet. It is impossible with such arrangement of windows to get thorough and even distribution of the incoming currents. Stables ventilated in this way are invariably cold and draughty. Not only was it impossible to get good circulation of air in the stable, but under certain conditions it was not possible to get a pure supply. In case the incoming currents were from the yard enclosed on all sides by high buildings, they were frequently loaded with those noxious gases derived from the decomposing excrement in the yard.

The general plan of the barn necessitated a faulty arrangement of the animals in the stable. The report says "there are four rows of stalls running across the barn." Later there was added a fifth. The box-stalls in the west end were similarly arranged and were separated by partitions extending from the floor nearly to the ceiling.

These rows ran north and south and were between opposite windows, a condition which, with simple sliding windows, can never give satisfactory results in ventilation.

The animals in the center of the rows do not get their share of the fresh air while those near the open windows are subject to draughts. A much better arrangement when possible, is to place the animals in rows running lengthwise of the stable, either facing them toward the walls or toward the central aisle, and instead of sliding windows have them hinged at the bottom, dropping inward at the top. This arrangement serves to direct and distribute the incoming currents of air before coming in contact with the cattle.

HISTORY OF THE COLLEGE HERD.

Two years before the building of the barn described in this bulletin the college herd, according to the report of 1868, consisted of the following animals: "One Ayrshire and one Alderney bull calf, three pairs of oxen, eighteen three-year-old steers, fifteen yearlings, all grade shorthorns; and three milch cows." The bull calves were presented by Dr. George B. Loring of Salem.

The following year the herd consisted of three pair of oxen, four cows, fourteen two-year-olds, three yearlings and one yearling bull.

In the year succeeding, the stock was largely increased by the addition to the herd of a number of pure bred and native animals. The pure breds were of the Shorthorn, Devon, Ayrshire and Jersey breeds and came into the possession of the college as gifts, through the generosity of its friends in different towns of Massachusetts and Connecticut.

The Shorthorns were represented by a bull "Mountain Lad," a cow "Young Acacia," and two heifers "Yarico 57" and "Autumn Rose." The Devons consisted of a bull "General Lyon," and two cows "Gem 3d" and "Winona 2d." The Ayrshires were a bull "Colfax," and a heifer "Lulie"; while the Jersey herd was composed of a bull "Essex," a bull calf "Enterprise," and a cow "Lucy."

Besides the above named pure bred animals, the college had forty natives, mostly cows and steers designed for slaughter, and two pair of cattle.

In 1870 the number of pure bred animals in the herd was as follows, fourteen Shorthorns, five Ayrshires, four Devons and four Jerseys, while the number of grades had decreased. During the year following the stock on the farm was largely increased by birth and gift. From the latter source there was added, the Shorthorn bull "Adonis," the Swiss bull "Belmont," an Ayrshire bull "Aberdeen," the Holstein bull "Fourth Highland Chief." a Brittany bull "Upton," a heifer "Pauline," and a Jersey bull "Grand Duke." Two imported Jersey cows were added by purchase.

From this time to 1879 the herd consisted of about fifty animals, composed in greater part of pure breds, for it appears at this time that it was the policy of the college to increase the number of pure bred animals and decrease the number of grades. From the descriptions and pedigrees published in the reports of this period it is apparent that the herd contained many noted animals to represent the different breeds.

We are led to believe that the presence of tuberculosis was not recognized at this period from the fact that in one of the reports of this time we find the following statement: "The stock as a rule has been thrifty and disease has not troubled in any form."

In 1879 the herd was reduced to twenty-five, all but two of which were pure blood Ayrshire. The reason for this appears in the following: "The trustees felt obliged, by the advice of the Governor and council and the existence of a very considerable debt . . . . to dispose of the Shorthorn, Jersey and Brittany cattle belonging to the farm."

Within the next three years the herd nearly doubled: it included forty-three head, "in good condition with many choice animals." A year later there were forty-two animals all of which were Ayrshires.

In 1886 several grade cows and a Guernsey bull were added The remodeling of the stable was recommended to "produce better quarters for the stock and to economize expenditure of labor in its care and management."

Again, two years later, a change in live stock had been effected "so that instead of a herd of Ayrshires, grades, and common stock, simply for milk production, there are now illustrative herds of five breeds, thus enumerated, nineteen Ayrshires, five Guernseys, eight Holstein Friesians, seven Jerseys, and six Shorthorns, a total of forty-five head, or one more than a year ago. Of the present number ten are males, some of these being for sale." Some of the animals in the herd at this time appear in the records of the tuberculin test which follow.

Those alterations of the stable, before mentioned, which consisted in part of the removal of the building on the south side of the yard and the substitution of a fence in its place was made in 1889. The health of the stock at this time was referred to as follows: "All of our animals with few exceptions are in a very thrifty condition."

In order to use the hay and grain grown on the farm to the best advantage and to avoid the purchase of manure it was thought best to increase the number of animals in the herd by purchase of grade cows. Accordingly, in October, 1890, twenty-eight head were added making a total of sixty-five animals.

Many of these grades were kept on the farm until the stable was burned; after which they were slaughtered. Their condition is noted in the tables of the tuberculin test. During the year the sale of several young bulls was made. From this time to the first of the year 1894 the number of animals in the herd remained about the same, few new animals were purchased, and it was thought best considering the existence of tuberculosis in the herd not to dispose of more animals from the place except for slaughter. The advisability of the precaution has been demonstrated by the autopsies.

In this brief sketch of the history of the college herd that occupied the stable already described, from 1867 to the time of its destruction by fire in the present year, none but the pure bred stock have been included as it was impossible to learn the source of the native or grade animals.

While it has been the intention to determine the source of all the pure bred animals, in all probability some have been omitted. The records show that nearly all were acquired by gifts from friends of the college although a few were bought.

Within the time mentioned at least fifty pure bred bovines were acquired and owned by the college together with some twenty lots of other domestic animals consisting of sheep, swine and horses. These animals were collected from three different countries, eight or nine states, about fifty towns, and can be traced to at least fifty separate herds. In most instances, only the herds are referred to in which the animals were, immediately before coming into the possession of the college. Taking into consideration the history of the pure-bred stock that may have been omitted, together with the grade animals that were frequently added to the herd, it would be safe to estimate that about seventy-five towns and one hundred herds were represented in the college herd during the twenty-seven years between the acquisition of the first two bull calves and the last animals purchased.

Without doubt many of the pure bred cattle came from old established herds which were kept in close warm stables and were forced to the production of large quantities of milk, in fact were kept under the conditions favorable to the development of tuberculosis.

The course pursued in the early days of the college for the collection of a herd was decidedly bad, viewing the subject from the standpoint of to-day and knowing what we now do of the causes, spread and propagation of the infectious diseases of animals. For it has been repeatedly demonstrated that all contagious diseases of both men and animals are the most common along the lines of traffic and also when persons and animals are collected together in large numbers or when there is frequent change of location. These conditions are most favorable for the existence and rapid spread of the infectious material which gives rise to this class of diseases. That this was the case with the herd under consideration appears in the study of tuberculosis in the college herd.

The first knowledge that we have of the existence of tuberculosis in the college herd dates back to about the year 1871. At that time a fat cow was sold to a butcher in North Amherst and at the time of slaughter it was found that the pleural surface of the thorax was thickly studded with large and small nodular growths, some of which were filled with pus and others with caseous or calcareous material. The true nature of these excrescences was not recognized. No one even suspected that they were the result of disease, but regarded them as an abnormal growth and a curiosity, consequently the fore quarters of the carcass were returned to the college and placed on exhibition to the public. The opportunity of seeing the peculiar malformation was improved by many of the people in Amherst and the surrounding towns. Professor Stockbridge now says that as he remembers the appearance of the tubercles it was one of the most marked cases of this form of tuberculosis that he has ever seen.*

The first reference made in the reports to the existence of tuberculosis among the cattle is found in that of 1873, in which the farm superintendent says, "The only loss by death was the Devon cow "Gem 3d." Her disease so far as symptoms were concerned was a most obscure one, but a post-mortem examination by Professor Clark revealed the fact that her trachea, lungs, liver, pleura and whole thoracic cavity were affected by a morbid growth, apparently of a scirrhous nature. The viscera were removed by Professor Clark for microscopic examination." Farther on in the report he again refers to the subject as follows: "In this connection, I may mention that by many cow-doctors the symptoms were referred to horn-ail, and it was only with the greatest difficulty that I prevented the most zealous from boring the suffering creature's horns and stuffing them with cayenne pepper, spirits of turpentine and other soothing preparations."

Professor Clark in the report of his department for the same year says, "There remains yet to be reported upon the autopsy of the Devon cow which died of a wasting disease last summer."

In relation to this subject the farm superintendent the following year, says, "In my report of last year I referred to the case of 'Gem 3d (502), a valuable Devon cow, who was slaughtered after a lingering illness; and whose viscera were found to be loaded with tuberculous deposit. Her daughter, 'Enid' (934½), and her son 'Arthur' have since given evidence of being affected, and have therefore been slaughtered, and portions of their organs showing the insidious character of the disease, have been preserved for the use of the professor and students in veterinary science. This reduced the Devons to three viz: the seven-year old bull 'General Lyon' (232) and the cow 'Pixie' (1199) and her calf 'Peri.' These were in no way related to 'Gem,' were perfectly healthy, and excellent specimens of the breed; but, by vote of the executive committee, I was directed to dispose of the remaining Devons and the Swiss, and I accordingly sold the Devon cow and calf to Mr. E. O'Rourke of New Brighton, Pennsylvania and had the Swiss and Devon bulls slaughtered."

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* These facts as recorded have been furnished by the Hon. Levi Stockbridge, then Professor of Agriculture at the college.

That this measure was not adopted to eradicate or limit the spread of the disease in question seems probable, for in the following paragraph of the report we read: "The keeping of many breeds of animals adds materially to the expense of the farm, as well as to the anxiety and care of the superintendent." At the same time the advisability of keeping representatives of the different breeds of cattle for the benefit of the students was not forgotten.

From the information obtained through Professor Stockbridge and the preceding quotations we are certain that tuberculosis existed in the college herd; and that it occasionally caused slight trouble among the animals for a few years afterwards, we may conclude from a section of the farm report which appeared a few years later, that reads: "The stock has been thrifty and productive. A few animals which fell short of a high standard of excellence have been slaughtered, or disposed of, with full notice of all defects, while others of pure descent and *unimpeachable* character have been sold for remunerative prices."

From this year to 1890 there were occasional deaths in the herd from tuberculosis, but at no time can I learn that there were during one season any considerable number lost.

In a letter to the President of the college, Professor Brooks under date of January 3, 1893, makes in part the following statement in regard to the condition of the stables and the existence of tuberculosis among the cattle:

"In spite of our utmost attempts to disinfect our barn, it appears to be thoroughly infected with the germs of tuberculosis. The first case of this disease in our barn occurred before 1880, and from that time to the present, losses of valuable animals have occasionally happened. When I assumed responsibility for the management of the college farm, in 1889, I found two animals in the barn affected with tuberculosis. These were slaughtered, and matters were allowed to run until the winter of 1890, and there was little indication of the presence of the disease.

Becoming somewhat alarmed, in view of the statements of certain veterinarians as to the condition of our herd at this time, Dr. James Law was called in. He made a thorough examination of every animal in the barn, and sent in a report which, as you are aware, was quite reassuring in its character. Two animals slaughtered by his advice were found diseased at this time; but, acting upon his suggestions as to disinfection, ventilation, etc., no further trouble was experienced until the winter of 1890-91, during which we slaughtered nine animals in the early stages of this disease. Since that winter we have had occasional cases, but in no single season as many. Still, it appears to be impossible to eradicate the disease in our present stable. That it is greatly aggravated by the breathing of impure air cannot be doubted. The disease makes no progress as a rule in summer, when our animals have pure air. It is impossible to give them such air in our stable as at present arranged with the cellar for manure below. It is imperative that we have a barn constructed in such a manner as to secure better hygienic conditions. With such conditions we may yet have occasional cases of tuberculosis for a time, for the disease is everywhere among New England cattle, and it is most insidious in its approaches; but, having perfect sanitary conditions, I should confidently anticipate controlling it,—keeping it within very narrow limits from the first, and perhaps ultimately eradicating it from our herd."

The writer becoming connected with the college shortly after the examination of the cattle by Dr. Law is fully aware of the details of the disinfection of the stable. The parts occupied by animals were several times thoroughly treated with lime whitewash and strong corrosive sublimate solution. This was applied to all parts of the walls by the use of brushes. Chloride of lime and saturated solutions of crude carbolic acid were applied to all parts of the floors and mangers and other fixtures of the building. This process was occasionally repeated by advice of the writer after assuming the position of veterinarian in the college.

Realizing at the time the importance of a liberal supply of fresh air and its relation to the preservation of the health of animals and the absolute necessity of it in combating this disease, as thorough ventilation as the existing circumstances permitted, was procured. And this with good results, for after the slaughter of thirteen animals during the years 1891 and 1892 hardly a case developed sufficiently marked symptoms to render a diagnosis of tuberculosis possible by physical examination. And still we are led to believe from the autopsy made at the time of slaughter later on, that many of the animals must have been slightly affected prior to this period.

At the time of the examination of the animals by Dr. Law and for some time after, nothing was known in this country of the use of tuberculin as a diagnostic agent of this disease and we had confidently expected up to the date of its introduction to be able by the weeding-out process, immediate slaughter of suspicious animals, by careful selection, and breeding and good sanitary surroundings to eradicate the disease from the herd. That in all probability we should never have been able to accomplish this is shown by a study of the records of the tuberculin tests.

The autopsies made upon the thirty-two animals slaughtered in June of 1894 revealed the fact that only seven were free from the disease, and still only two of the whole number were badly affected, and in these the tubercles were in such condition and so situated that the general health of the creatures had not suffered, neither had physical symptoms developed so that by the ordinary examination a diagnosis of tuberculosis could have been made.

Many of the twenty-eight grade animals purchased in October, 1890, were slaughtered at this time. Since about the year 1890 no animals have been sold from the herd except for immediate slaughter. All carcasses found affected have been disposed of by rendering or deep burial.

The tuberculin tests were begun in October, 1892, and concluded in June, 1894. During that time numerous injections were made upon animals in the college herd. In all cases the animals have been slaughtered and in every instance a careful post-mortem examination made to determine the presence of tubercles. In some of the cases but not all, when it was doubtful whether tuberculosis existed, parts have been examined microscopically to make if possible a correct diagnosis. With those animals that were pronounced sound after having given a reaction it was not possible to discover tubercles after a careful search at the time of slaughter. In some no part of the tissues was submitted to microscopical examination for it was impossible to find anything that presented a single character of a tubercular lesion. That they may have been present we cannot absolutely deny, but can say after a most searching examination that we were unable to find anything resembling a tubercle to submit to examination.

The tuberculin used in the tests was Koch's tuberculin (Tuberculinum Kochii) imported from Germany.

Before injection it was diluted, 1 c. c. of tuberculin being mixed with 9 c. c. of 1% carbolic acid solution made with distilled water.

Previous to its use the temperature of the animal was taken on one or several occasions, by means of a fever thermometer inserted into the rectum, the last reading being taken immediately before the injection was made. The injection of the tuberculin under the skin was made by the use of a hypodermic syringe, at a point just back of the scapula about one-third the distance from the spines of the vertebrae to the point of the elbow. The quantity of tuberculin used in each case will be found recorded in the tables of the tests. It varied according to the size and condition of the animal and ranged from 0.05 c. c. to 0.5 c. c. of the concentrated drug (ten times the quantity of the dilute solution).

The syringe before being used and between injections in different animals was in all cases carefully treated with 5% solution of carbolic acid or a solution of corrosive sublimate, one part of the drug to 1000 parts of water. After the tuberculin had been used, in most cases, the part was again wet with the antiseptic solution. In the use of tuberculin, care was taken to get the solution well under the skin but not into the fleshy part beneath.

Subsequent to the administration of the drug, during the continuation of the test, large quantities of cold water were not allowed; in all other respects the animals were given their usual treatment.

For a period of about twenty-four hours after injection the temperature was taken at intervals of several hours, and the animals were closely watched to determine the effects of the tuberculin. In some animals there was noticed at the point of injection a somewhat hard and painful swelling, in others trembling of the muscles, most marked about the region of the hips, in some there was suspension of rumination, in others, slight diarrhoea and lessened secretion of milk. All of these effects were, however, only temporary. In the autopsies of animals recently treated careful examination failed to reveal any serious or permanent changes either at the point of injection or in other parts of the body as a result of the use of tuberculin. So far as determined no particular condition of the animals predisposed to the appearance of these slight symptoms.

In connection with the records of the first three animals tested there appears a short history of the animals and after the table of the temperatures etc. a record of the post mortem examination. In all others the records are arranged in tabulated form.

Jersey Bull, Don Pedro Torment. Born January 1888. Presented to the college in 1889. During the summer of 1891 he was worked in yoke with a purebred Guernsey bull and was to all appearances perfectly healthy. At this time the foreman on the farm said that his power of endurance was greater than that of the animal with which he was worked.

There was, however, at this time an occasional, deep, loose, sing cough. During the summer of 1892 there was a considerable loss of flesh and a development of general unthriftiness. Late in the season there appeared at the patella articulation of one leg a well-defined, hard, tense, painful swelling, about the size of the hand, this increased in size, became more painful on pressure, causing increased lameness. At this time the animal was isolated with the idea of submitting him to the tuberculin test. He became more and more emaciated notwithstanding that the appetite remained good and the food supplied was abundant and wholesome.

From October third to the twentieth several microscopic examinations were made of the mucus discharged from the nostrils but at no time were the bacilli of tuberculosis found.

Neither auscultation nor percussion of the thorax revealed symptoms indicative of extensive tuberculous lesions and while an occasional deep, full, moist, single cough was heard it was not frequent nor troublesome.

	Time of day	Temperature	Pulse	Respirations
Oct. 4, 1892	3 P. M.	103.2	72	18
“ 5, “	3 P. M.	103.4	60	20
“ 6, “	9 A. M.	101.4	54	18
“ 7, “	3-30 P. M.	104.	66	27
“ 8, “	9 A. M.	102.2	60	22
“ 9, “	11-30 A.M.	103.	60	20
“ 10, “	3 P. M.	104.	66	21
“ 11, “	3 P. M.	103.	60	20
“ 12, “	12 noon	103.1	60	20
“ 13, “	8-30 A.M.	103.	60	20
“ 14, “	3 P. M.	104.	69	30
“ 17, “	9 A. M.	104.	66	20
“ 17, “	4-30 P. M.	104.	66	22
“ 17, “	5 P. M.	Injected	0.5 c. c.	tuberculin.
“ 17, “	11 P. M.	105.	66	24
“ 18, “	5 A. M.	**105.4**	72	24
“ 18, “	10-30 A.M.	104.	72	24
“ 18, “	3 P. M.	104.	—	24
“ 19, “	12 noon	104.	66	28
“ 20, “	8-30 A.M.	102.4		
“ 20, “	8-30 A.M.	Injected	0.25 c. c.	tuberculin
“ 20, “	1-30 P.M.	103.2	60	28
“ 20, “	6-30 P.M.	**104.1**	66	28
“ 20, “	9.30 P.M.	103.2	66	28

Autopsy made October 24, 1892.

Just underneath the skin of the patella region there was found a small abscess containing creamy pus. About the articulation there was a large amount of fibrous tissue, in the center of which there appeared a nodular growth about the size of a hen's egg, this contained in its center caseous material. The synovial membrane was roughened and in many places covered with small diffuse growths. The articular surface of the bone was normal. In some parts of the abdominal cavity small single tubercular nodules were found. The lungs contained many tubercles varying in size from a small shot to a large orange. The inferior portion of the surface of the lungs and walls of the thorax were thickly studded with new growths.

Case No. 2 was that of a pure blood Ayrshire cow, nine to ten years old. She had been owned and kept in the college barn for years, and had stood in the stall nearest the doors at the southeast corner of the stable. This animal at the time of the test was dry and fat, ready for the butcher and so far as known perfectly free from tuberculosis.

	Time of day	Temperature	Pulse	Respirations
Oct. 24, 1892	8-30 A.M.	102.	66	24
" 27, "	8-30 A.M.	101.4	72	20
" 27, "	6 30 P.M.	101.2	60+.	24
" 28, "	7 A. M.	102.1	—	20
" 29, "	5 P. M.	102.	—	—
Nov. 4, "	12 noon	101.3	—	24
" 5, "	5 P. M.	101.	—	—
" 7, "	3 P. M.	101.	—	—
" 11, "	4-30 P.M.	101.2	84	25
" 12, "	8 A. M.	102.	—	—
" 12, "	8-30 A.M.	Injected	0.25 c. c.	tuberculin
" 12, "	5 P. M.	101.2	—	—
" 12, "	10 P. M.	105.	—	—
" 12, "	11-50 P.M.	**106.2**	—	—
" 14, "	3 P. M.	105.	—	—

Autopsy, Nov. 22, 1892.

No evidence of disease found in any part of the body except eight or ten very small tubercles in the lungs, none of which were larger than a small pea. These were well distributed throughout the lung tissue and were below the surface, none being found directly beneath the pleura pulmonalis.

Case No. 3. Black grade cow, eight to ten years old.

This cow was one of the twenty-eight purchased some two years before, (See page 15) and after purchase was kept under exactly the same conditions as the others obtained at that time.

At the beginning of the tuberculin test, she was slightly emaciated and was occasionally noticed to be tympanitic but this never caused serious trouble.

A deep, full, moist, single cough was sometimes heard from her but no more than the usual quantity of mucus was ever noticed about the nostrils.

			Time of day	Temperature	Pulse	Respirations
Oct.	18,	1892	3 P. M.	103. *	72	42
"	27,	"	8-30 A.M	102.	66	42
"	27,	"	6-30 P.M.	102.3	—	42
"	28,	"	7 A. M.	101.3	—	36
"	29,	"	5 P. M.	101.4	—	—
Nov.	4,	"	11-50 A.M.	102.2	66	30
"	5,	"	5 P. M.	102.	66	24
"	7,	"	3 P. M.	104.	72	42
"	8,	"	3 P. M.	103.4	72	50
"	11,	"	4-30 P.M.	104.	66	36
"	12,	"	8 A. M.	100.4	60	24
"	12,	"	8 A. M.	Injected	0.25 c. c.	tuberculin
"	12,	"	1 P. M.	103.	—	—
"	12,	"	5 P. M.	**105.4**	66	35
"	12,	"	10 P. M.	105.	66	30+
"	12,	"	11-50 P.M.	104.	—	—
"	14,	"	3 P. M.	103.1	—	—

*In heat.

Autopsy, Dec. 15, 1892.

Lungs were filled with tubercles, from four to six inches in diameter, most of them containing large quantities of caseous material with but little pus.

The bronchial glands were much enlarged and filled with caseous material. The lower portion of the lungs and thorax were thickly covered with tubercles, in places adherent. One small tubercle was found in the liver.

The records of the other tuberculin tests appear in the following tables.

Number.	NAME.	Breed.	Age.	Date of Test.	Quantity of Tuberculin.	Normal Temperature.	Temperature—hours after injection.							Date of Slaughter.	Result of Autopsy.
				1893		4 P. M	6½ hrs.	11½	15½	19	23	26		1893	
4	*Cornelia Artis,	Holstein	9 yrs.	Nov. 10	0.2 cc	99.4	101.4	104.4	105 2	**105.4**	104.2	—	—	—	
5	*Emelia Artis,	Holstein	9 "	Nov. 10	0.2 cc	100.1	101.4	105.2	**106.1**	106.1	105.	—	—	—	
6	*Cornelia Pledge,	Holstein	7 "	Nov. 10	0.2 cc	100.3	100 3	104.1	105.	**106.3**	103.2	—	—	—	
7	*Emelia Pledge,	Holstein	7 "	Nov. 10	0.2 cc	102.2	102.3	104.	106.1	**106.4**	106.	—	—	—	
8	*Belle Pledge,	Holstein	6 "	Nov. 10	0.2 cc	101.4	102.	102.2	105.	**107.**	106.	—	—	—	
9	*Marabell,	Holstein	3 "	Nov. 10	0.2 cc	101.3	100.2	101.2	101.	101.	101.2	—	—	—	
10	*Twilight Artis,	Holstein	4 "	Nov. 10	0.2 cc	101.	99.1	105.2	**105.3**	105.	103.3	—	—	—	
11	Pledge of M. A. C.,	Holstein	2 "	Nov. 10	0.2 cc	102.1	102.	102.	104.	**105.**	103.1	—	—	Dec.	Sound.
12	*Marabell II,	Holstein	2 "	Nov. 10	0.15 cc	102.1	102.4	**106.**	105.2	105.1	105.1	—	—	—	[cles in left lun
13	Cornelia Pledge II,	Holstein	2 "	Nov. 10	0.15 cc	102.1	103 4	**105.1**	102.3	101.4	101.4	—	—	Nov. 20	Small cluster of tub
14	Marabell Artis II,	Holstein	calf	Nov. 10	0.075 cc	102.	102.	101.1	102.1	102.	103.	—	—	—	Sound.
15	Cornelia Pledge III	Holstein	calf	Nov. 10	0.05 cc	102.3	102.2	103.	103.1	102.3	102.3	—	—	—	Sound.
16	*Norma,	Ayrshire	4 yrs.	Nov. 10	0.2 cc	101.3	101.	101.1	103.3	**106.**	103.4	—	—	—	
17	*Brenda,	Ayrshire	5 "	Nov. 10	0.2 cc	101.1	101.4	101.	101.1	101.3	103.1	103.3	—	—	
18	*Myrca Clifton,	Ayrshire	9 "	Nov. 10	0.2 cc	102.	100.1	104 2	105.3	**106.3**	104.2	—	—	—	
19	*Amelia Clifton,	Ayrshire	9 "	Nov. 10	0.2 cc	102 2	102.	103.2	106.1	**106.4**	103.	—	—	—	
				1894		4-30 P.	7 hrs.	12	15	18	21½			1894	
20	Midget,	Jersey	11 "	Mar. 2	0.25 cc	101-3	102.1	**107.**	106.	105.	104.2	—	—	Mar. 9	Lungs slightly affected
21	Midget II,	Grade Jersey	2 "	Mar. 2	0.15 cc	102.	101.3	**106.2**	106.2	105 2	105 1	—	—	Mar. 9	Lungs slightly affectec
22	Niobe II,	Grade Guernsey	2 "	Mar. 2	0.15 cc	101.4	102.	101.1	101.4	102.3	101.2	—	—	Mar. 9	Sound.
23	Beth Rainor,	Grade Ayrshire	2 "	Mar. 2	0.15 cc	101.4	102.3	102.1	**106.2**	101.3	100.3	—	—	Mar. 7	Sound.
12	Marabell II,	Holstein	2 "	Mar. 2	0.15 cc	102.	103.	**104.2**	103.3	103.	102.2	—	—	Mar. 7	Sound. [lun
24	Oakwood (Bull),	Ayrshire	4 "	Mar 2	0.3 cc	101.4	99.1	**107.**	104.1	102.	101.4	—	—	Mar. 6	Two small tubercles in
							7 hrs.	9½	12½	15½	18½	21½	24½		
9	Marabell,	Holstein	4 "	May 1	0.25 cc	102.2	103.2	103.2	102.	102 3	101.3	101.3	—	May 5	Sound.
16	Norma,	Ayrshire	5 "	May 1	0 25 cc	100.	101.	101.4	103.2	**105.**	102 5	101.4	—	May 5	Tubercles in lungs.
25	Hebe,	Jersey	4 "	May 1	0.25 cc	101.4	101.	101.3	**104.4**	102.4	104.4	104.4	—	May 5	Tubercles in lungs.
26	May	Grade Shorthorn	9 "	May 1	0.25 cc	101.3	100.4	102 4	105.4	**106.4**	105.2	105.4	—	May 5	Tubercles in lungs.
27	*Flora,	Native	11 "	May 1	0.25 cc	101.3	101.4	101.2	102.3	104.4	**105.**	104.	—	—	
28	Nancy,	Grade Shorthorn	11 "	May 1	0.25 cc	101.4	101.3	101.3	102.1	102.1	103.4	**104.2**	103.3	May 5	Slightly tuberculous.
29	[illegible]dle II,	Grade Holstein	2 "	May 1	0.15 cc	102.3	102.	105.	106.	**106.2**	105.	105.	—	May 5	Slightly tuberculous.

*Retested.

Number.	NAME.	Breed.	Age.	Date of Test.	Quantity of Tuberculin.	Normal Temperature.	Temperature—hours after injection.							Date of Slaughter.	Result of Autopsy.
				1894		7 P. M.	6 hrs.	10	14	17	20	23	26	1894	
30	Mabel,	Grade Shorthorn	7 "	June 11	0.25 cc	101.	102.	105.	106.	**103.1**	105.	104.2	104.	June 14	Slightly tuberculous.
31	Topsy,	Grade Shorthorn	8 "	June 11	0.25 cc	101.	100.	100.3	101.1	102.	101.4	101.2	100.3	June 16	Sound.
32	Madge,	Grade Ayrshire	11 "	June 11	0.25 cc	101.2	—	—	104.2	**106.1**	105.4	104.2	104.4	June 16	Slightly tuberculous.
33	Nora,	Native	7 "	June 11	0.25 cc	101.	—	101.	101.2	102.	102.	102.	101.3	June 16	Sound.
34	Meg,	Grade Shorthorn	9 "	June 11	0.25 cc	101.3	100.	100.2	101.3	**103.**	102.	101.	101.1	June 13	Slightly tuberculous.
35	Roxy,	Grade Shorthorn	8 "	June 11	0.25 cc	102.	101.1	101.	101.2	103.1	101.4	102.	102.	June 16	Sound.
36	Daisy II,	Guernsey	2 "	June 11	0.15 cc	100.4	100.	101.	105.	**105.1**	103.2	103.1	102.	June 13	Slightly tuberculous.
17	Brenda,	Ayrshire	5 "	June 11	0.25 cc	101.	100.3	101.	102.	**105.**	103.2	103.1	102.	June 13	Slightly tuberculous.
37	Daisy,	Guernsey	5 "	June 11	0.25 cc	101.1	101.	101.1	102.	**105.**	104.2	102.2	102.	June 13	Slightly tuberculous.
38	Ruby,	Jersey	6 "	June 11	0.25 cc	101.	100.	102.	105.2	**106.3**	104.3	103.1	102.	June 14	Well marked lesions.
18	Myrca Clifton,	Ayrshire	9 "	June 11	0.25 cc	100.4	101.	101.2	104.3	**105.3**	104.2	103.	102.2	June 13	Well marked lesions.
39	Lila,	Grade Guernsey	2 "	June 11	0.15 cc	101.4	101.	102.	103.3	**106.**	105.	102.3	102.3	June 13	Slightly tuberculous.
40	Ruth,	Grade Jersey	2 "	June 11	0.15 cc	100.4	99.4	103.3	**106.2**	106.2	106.	105.	105.	June 13	Slightly tuberculous.
41	Esther,	Grade Shorthorn	9 "	June 11	0.25 cc	101.	100.	101.2	100.2	**103.4**	103.3	103.3	103.3	June 16	Slightly tuberculous.
42	Milly,	Jersey	5 "	June 11	0.25 cc	102.	101.2	101.4	104.1	**106.3**	105.2	104.2	103.	June 14	Slightly tuberculous.
43	Twilight Artis,	Holstein	5 "	June 11	0.25 cc	102.	101.	99.3	103.2	106.	**106.4**	102.2	102.3	June 14	Slightly tuberculous.
6	Cornelia Pledge,	Holstein	7 "	June 11	0.25 cc	102.1	100.2	103.	104.	106.	**106.1**	103.3	102.3	June 14	Slightly tuberculous.
8	Belle Pledge,	Holstein	6 "	June 11	0.25 cc	101.3	101.2	102.1	105.	**105.2**	105.2	102.3	101.4	June 14	Slightly tuberculous.
19	Amelia Clifton,	Ayrshire	9 "	June 11	0.25 cc	102.3	101.1	101.	104.	106.3	**106.4**	103.4	102.2	June 13	Slightly tuberculous.
5	Emelia Artis,	Holstein	9 "	June 11	0.25 cc	101.4	101.2	103.2	104.4	**106.4**	106.1	105.2	103.3	June 14	Slightly tuberculous.
4	Cornelia Artis,	Holstein	9 "	June 11	0.25 cc	102	101.	101.3	101.	103.4	**104.2**	103.1	101.4	June 14	Slightly tuberculous.
44	Fanny,	Jersey	11 "	June 11	0.25 cc	102.	100.4	98.4	100.1	103.	**106.3**	101.3	101.1	June 15	Slightly tuberculous.
45	Alice,	Grade Ayrshire	8 "	June 11	0.25 cc	101.3	101.	103.	104.	**105.**	104.	102.3	102.	June 16	Slightly tuberculous.
46	Viola,	Jersey	8 "	June 11	0.25 cc	101.3	101.3	101.2	**104.4**	104.3	104.	102.	101.2	June 15	Very slightly tuberculo
27	Flora,	Native	11 "	June 11	0.25 cc	101.3	102.1	100.	101.3	**104.3**	104.1	101.2	101.3	June 15	Very slightly tuberculo
47	Maud,	Grade Shorthorn	9 "	June 11	0.25 cc	102.	100.4	101.	103.	**104.2**	103.4	102.4	101.4	June 15	Generalized tuberculos
48	Roma,	Grade Shorthorn	8 "	June 11	0.25 cc	101.4	100.1	99.3	101.	101.3	101.2	101.3	101.4	June 16	Sound.
49	Dinah,	Grade Holstein	8 "	June 11	0.25 cc	100.4	100.3	100.2	101.1	103.	102.2	102.2	102.1	June 15	Sound.
50	Niobe,	Grade Shorthorn	9 "	June 11	0.25 cc	100.	99.4	100.	101.3	**105.**	103.3	103.3	102.	June 15	Slightly tuberculous.
7	Emelia Pledge,	Holstein	7 "	June 11	0.25 cc	101.4	100.	101.4	102.	**104.3**	103.	102.3	102.4	June 14	Slightly tuberculous.
51	Violet,	Jersey	3 "	June 11	0.25 cc	100.	101.	101.2	101.3	102.	101.4	102.	102.	June 16	Sound.
52	Asia,	Jersey	9 "	June 11	0.25 cc	99.	100.	101.3	102.	103.	102.	102.3	101.1	June 16	Sound.

From a careful study of this subject as presented in the foregoing pages it seems that certain conclusions can be drawn which bear important relations to the introduction, spread, propagation and results of tuberculosis in this particular herd and which perhaps may be with propriety applied in a general way to the extensive and alarming prevalence of the disease among cattle in Massachusetts.

1. That it is unsafe to purchase animals to add to a healthy herd from a herd in which tuberculosis has existed.

2. That poor sanitary surroundings, especially imperfect ventilation and insufficient light are favorable to the rapid spread of tuberculosis among cattle.

3. That it is much better to dispose of excrement outside of stables than in cellars underneath them.

4. That mangers and other stable fixtures which increase the amount of surface, cracks and corners that cannot be easily cleaned are objectionable from the fact that when the germs of tuberculosis become scattered, under such conditions they are not easily destroyed by the use of disinfecting fluids.

5. That infected stables bear close relation to the propagation of the disease.

6. That even by the use of strong disinfecting fluids it is very difficult if not impossible to rid an old stable of the germs of tuberculosis.

7. That the diagnosis in most cases of this disease by physical examination is impossible.

8. That in tuberculin we have an exceedingly delicate and reliable test for tuberculosis.

9. That tuberculin indicates the existence of tuberculosis in the lungs and other parts of the body, when objective symptoms are absent and when no germs can be discovered by microscopical examination of the mucus from the nostrils.

10. That its use is not followed by any ill effects of a serious or permanent nature.

11. That in some instances the injection of tuberculin produces a marked rise of the internal temperature when no tuberculosis exists. (Pledge of M. A. C., Beth Rainor and Marabell II.)

12. That in some cases when tubercles are present in the body its injection is not followed by a well defined reaction. (Meg.)

13. That the reaction following the use of tuberculin bears no relation to the extent or development of the disease.

14. That it is impossible to formulate a rule by which we can say that certain variations of the temperature may or may not indicate the presence of tubercles.

15. That in tuberculin we have the only means by which we can eradicate tuberculosis from among our cattle.

16. That our old styled and unsanitary stables thoroughly infected with the germs of tuberculosis make the complete eradication and suppression of this disease well nigh impossible.

AN OUTBREAK OF RABIES AMONG CATTLE.

Early in June of 1894 there appeared among the cattle upon several of the farms in Ware, Massachusetts, a peculiar disease. It developed in animals under varying conditions; no class seemed to escape, calves, steers, and cows, dry and in milch, fat and poor, in calf and farrow were subjects of it.

Premonitory symptoms were absent, in some cases its full effects were noticeable within a few hours from its start. It ran an acute course, invariably terminating fatally within a few days. Cattle were found dead in the pastures, others were driven from the pastures at night to all appearances perfectly well, and in the morning would show the most alarming symptoms. The disease would continue to increase in severity and extent, producing death in a short time.

The simultaneous appearance of the disease among several herds of cattle with frequent death caused no little excitement among the farmers of the section. Numerous theories were advanced to explain the cause of the malady. Many of the people thought the mysterious disease caused by the animals eating poisonous plants in the pasture, others considered it a result of arsenic or other poisonous material administered with malicious intent; but why it should attack certain animals in a herd and not others kept under exactly the same condition, or why it should appear among the cattle in one pasture while those in an adjoining one escaped—these with other peculiarities were mysteries for which there seemed to be no satisfactory explanation.

With a view of ascertaining the cause and nature of this peculiar disease, the writer on June eighth, in company with Mr. Cheever and Dr. Etienne of Ware, made a visit to the farms in the section of the town where the disease was and had been most prevalent.

We went at once to the farm of Miss Mary Howe, just over the boundary line between Ware and Enfield, in hopes of finding an animal recently dead upon which to hold a post mortem examination.

In this we were successful, for there we found a cow that had died the day previous and one that had died that morning. The latter was selected and a post mortem examination made which revealed nothing abnormal about any parts of the body except a few old adhesions in the abdominal cavity, indicating that inflammation had previously existed there. The brain was included in the examination, and was carefully removed with a part of the spinal cord and wrapped in a clean cloth to be preserved for future inspection and investigation.

After completing the autopsy, and examining a cow in the stable that had that morning begun to show for the first time symptoms of the disease, we drove to the farm of Mr. St. Jamin and learned that a short time before he had had two yearling heifers die in the pasture with the same disease. From Mr. St. Jamin's we proceeded to the Town farm. Through the kindness of Mr. W. H. Perkins we were informed of the history of the outbreak of the disease among the cattle upon that farm.

From the Town farm we drove some four miles to Mr. Cheever's place, where we found in the stable two cows, a brindle and a red one, that had been sick for two days. These were carefully examined in the stable, then were driven outside and watched for some time.

On June eighteenth another visit was made to Mr. Cheever's farm in order to continue the investigations by the examination of a ten months old heifer that was first noticed ailing two days before.

The character of the symptoms in all of the animals was nearly the same. In some instances they were more marked and appeared more quickly than in others, but the course did not differ greatly except as regards time.

As determined by examination and inquiry they were as follows: A disposition to leave the other animals in the herd, wandering about the pasture, jumping fences and running, loss of appetite, cessation of rumination, gradual and rapid suppression of secretion of milk, grating of the teeth with champing of the jaws: frequent attacks of bellowing, following in quick succession, being at first loud, clear and distinct, gradually growing weaker with a tendency to become continuous and higher in pitch, but less distinct. The temperature was normal and there was but slight alteration of the pulse. In an adult cow that had been sick six or eight hours it was about forty-eight per minute and nearly of normal strength. In a ten months old calf that had been suffering for two days and showed well marked symptoms it was found to be forty-eight with the temperature normal.

After an attack of a few hours' duration frequent stepping with the hind legs with an incessant whisking of the tail would be seen. Trembling of the muscles of the flank and hips invariably appeared, and as the disease developed this increased in severity and extent, including the muscles of the shoulder and anterior extremities. At the outset there appeared to be a peculiar expression about the face, due to the position in which the head and ears were carried and to the condition of the eyes. The neck was extended, with the head carried somewhat above the natural position of an animal when standing idle. The ears were erect. The eyes widely opened, with the pupils dilated. To every appearance the animals seemed to be somewhat surprised and intensely interested in some distant object.

The peculiar and most prominent symptom and one of the first to appear was *tenesmus*. The cows would stand from the first with tails slightly elevated and the muscles of the anus relaxed.

At frequent intervals and at any time when made to move, the tails would be still more raised and a slight effort made to expel fæces. When successful in the attempt, only a small quantity would be evacuated. This in most cases was normal in consistency and appearance with perhaps a slight increase in the amount of mucus present.

The functions of the urinary organs were not sufficiently interfered with to attract attention.

While all of the animals refused food, thirst was a prominent symptom and all in the first stages partook freely of water. In a single instance, the owner informed me, that one cow when first taken ill stood for the greater part of one day at the trough, frequently taking a few swallows and when unable to swallow endeavoring to lap the water. This she continued to do until a few hours before being slaughtered.

As the disease developed, the symptoms became more and more urgent, varying, however, in different animals. In some, they indicated the development of more intense cerebral irritation, producing a condition marked by great uneasiness and excitement; while in others, the symptoms indicated mental depression with a tendency toward paralysis.

In those cases where the animals were inclined to become more excited, the head would be carried higher, the eyes became more prominent, the bellowing louder and more frequent, appearing however in paroxysms continuing with some for hours with short intervals of cessation. The stepping with the hind legs was followed by occasional kicking at the belly and a reckless kicking backward as if to strike some object. There was pawing with the fore-feet and in some goring of the earth.

The movements were partially controlled but were unnatural, as was determined by driving two of the affected creatures that had been sick for two days over a narrow ditch, partially filled with water. They appeared to be conscious of the position of the ditch and controlled the action of the muscles sufficiently well to be able to cross without stepping in or falling, but it was approached cautiously with an appearance that indicated an uncertainty, and when the feet were raised to step across they were raised to a much greater height and with more of a feeling motion than was natural in such cases.

The general actions of the animals in these efforts might very appropriately be compared to the action of a man in his stocking feet feeling his way about in a dark room in which there were numerous chairs and other objects, or to that of a blind horse feeling his way along over rough and uneven places. The same symptom was exhibited by a ten months' old calf which had been sick two days, when made to step over a log eight or ten inches in diameter.

The cows were driven through a pool of water which was fifty or seventy-five feet across and eighteen inches or two feet in depth at its deepest part. They showed no hesitation or fear when made to enter the water and were rather inclined to remain standing in it.

At times they would attempt to drink, but so far as noticed little or no water was swallowed. No spasm or excitement was produced when an attempt was made.

Of two of Mr. Cheever's cows, the brindle and red ones (Nos. 3 and 4 of the table) both of which were taken sick on June sixth, he informs me under date of June fourteenth that the red cow died on Saturday, June ninth, about eleven o'clock A. M. and the brindle one Sunday, June tenth, at five o'clock P. M. He further states that on Saturday, before death, the red cow was very uneasy, and as long as she lived would follow and hook at the hens, and that there was some saliva about the mouth. Two hours after her death he opened her, but could find nothing abnormal, except that the blood was very black and thick. The brindle cow appeared better on Saturday until night, when she became restless and remained so while she lived. On Sunday, the day of her death, she caught sight of a dog through the cracks between the boards of the stable, and became very much excited, frothing at the mouth.

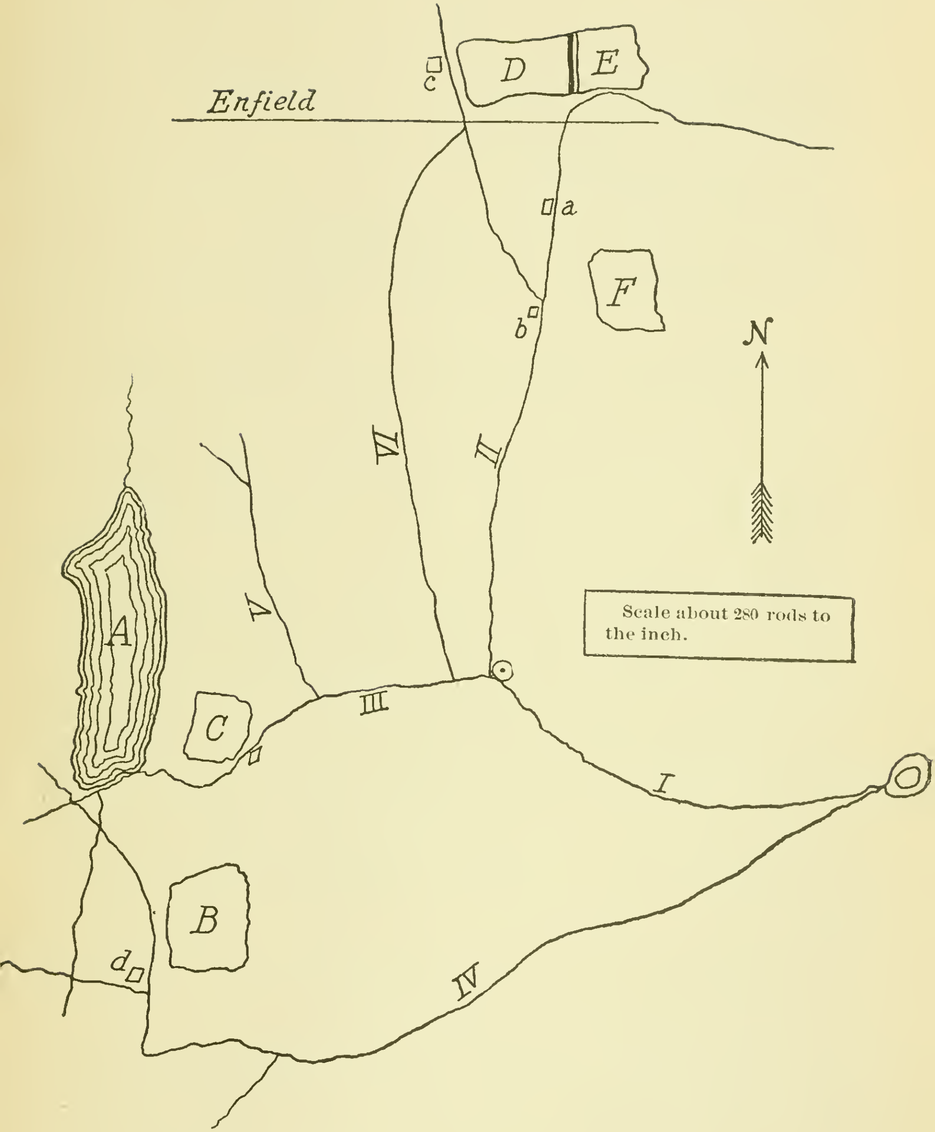
The tenesmus which was a prominent symptom with all in the first stages became more marked as the disease developed, and with all of the animals became the most prominent and *characteristic* symptom. Instead of standing with the tail slightly elevated and the muscles of the anus relaxed, they soon assumed a position with the back arched, the tail well elevated, the sphincter muscles so relaxed that the anus remained constantly open, and instead of an occasional slight effort to defecate there was the most pronounced jerky, spasmodic straining that could possibly exist. While this was almost constant, it was more pronounced, however, at times, and seemed to occur paroxysmally. During the paroxysms, the strains were at intervals of about ten seconds and were quite characteristic, being unlike corresponding efforts noticed in any other diseases with which the writer is acquainted. The effort was distinctly jerky and convulsive and was produced wholly by a *spasmodic* contraction of the abdominal muscles, instead of resulting from a tonic or progressive contraction. With each convulsive strain there was enlargement of the anus and expulsion per rectum of a small quantity of frothy mucus.

On account of the relaxed condition of the sphincter muscles and the expansion of the abdomen by relaxation of the abdominal muscles, large quantities of air were drawn into the rectum at the expiration of each strain; this became mixed with the mucus secreted, producing a frothy mixture which would be expelled with the next effort.

So characteristic was this symptom that an effort was made to procure a picture of an animal in this act, but without success.

The symptoms enumerated would gradually verge into symptoms indicative of paralysis and insensibility. The animals would fall and make frequent attempts to rise and after severe convulsive struggling would die.

With those animals in which the developing symptoms indicated greater depression and dullness instead of a disposition to remain active, there was a desire to stay quiet and recumbent with the nose resting upon the floor or the head thrown around on the side. There would, in such cases, be intervals of greater activity marked by elevation of the head and ears, protrusion of the eyes, attempts to rise, loud and frequent bellowing, switching of the tail, kicking and frequent spasmodic strainings. These periods of excitement and restlessness lasting from one to several hours would be followed by intervals of quiet with progressive symptoms of paralysis and insensibility. After a time the patient would become comatose and remain in that condition until death. In some instances the hopes of recovery were so small, the symptoms so urgent and distressing and the animals apparently in such pain that they were relieved of their suffering by slaughter. (Four animals in lot No. 2. See table.)


Enfield
c
D
E
a
F
b
N
VI
II
V
A
C
III
Scale about 280 rods to the inch.
I
B
d
IV

EXPLANATION OF DRAWING.

◎	Ware town.
Θ	Ware center.
I	Road from Ware town to Ware center.
II	Road from Ware center to Greenwich.
III	Road from Ware center to Beaver Lake.
IV	Road from Ware town to Palmer.
V	Road from Ware town to Enfield.
VI	Road over Brimstone Hill.
A	Beaver Lake.
B	Pasture of Perry Cheever.
C	Pasture of Mr. Crowley.
D	Pasture of Miss Mary Howe.
E	Town farm pasture.
F	Pasture of Mr. St. Jamin.
a	Town farm buildings.
b	Mr. St. Jamins' buildings.
c	Miss Mary Howe's buildings.
d	Perry Cheever's buildings.

With reference to the cause of the outbreak of this disease a careful study of the history of the case has been made,also some experiments which will be reviewed in detail further on in this paper. A map showing the location of the town centers with the roads leading to other towns and the location of the farm buildings and pastures has been prepared, in order to elucidate the facts obtained as they relate to the history of the outbreak.

An examination of the map shows that Mr. Cheever's place (d and B) is located in the southwest part of the town about three or three and one-half miles from the place of Miss Howe (c and D) which is in a northeasterly direction. Between the two at (C) near Beaver Lake is located Mr. Crowley's pasture.

Miss Howe's pasture, a part of which is in sight of the house, adjoins that of the Town farm, shown at E. The latter is about one half mile distant, but in sight from the Town farm buildings. Mr. St. Jamin's buildings are shown at b with the pasture (F) upon the slope of the hill about three-eighths of a mile distant across a little valley to the east. Nearly the whole of it is in full view from his buildings.

The two pastures at E and F are in the same valley and connected by a stretch of meadow land, comparatively level.

At the time of making the post-mortem examination of the cow at the farm of Miss Howe, June eighth, she incidentally remarked, ‘ I think my cattle would not have been sick if they had not been chased by dogs some weeks ago." Upon inquiry, it was learned from her that upon the eleventh of May she had in the pasture (located upon the map at D) ten animals,and during the early part of the forenoon they were driven by dogs from a distant part of the pasture to a part near the road, opposite the house. When they arrived in sight, it was seen that two dogs were among them, attacking and biting them fiercely. A boy went at once into the pasture and drove the dogs away. They disappeared in the direction of the town farm pasture. One he described as being a shepherd dog of about average size, with black body and tan or brown legs. The other, as a medium-sized animal, yellowish brown in color and of no particular breed.

After the dogs had been driven away, the cows being greatly frightened and excited were taken to the yard, and an examination showed some of them to have been badly bitten about the hips, legs and tail. On account of the frightened condition they were kept for several days in the barn and yard. During this time the wounds healed kindly, so that on the eighth of June only a few scratch-like scars could be found upon the body and legs of the animal subjected to post-mortem examination.

Later in the day we were informed by Mr. W. H. Perkins, superintendent of the Town farm,that during the forenoon of May eleventh his cattle, in the pasture adjoining that of Miss Howe, were attacked by two dogs one of which was a shepherd. They were so fiercely attacked and so thoroughly frightened that they broke through the pasture fence and came running at full speed to the stable. It was noticed that some were bitten upon the hind legs, the tail and adjacent parts of the body. Still later in the same forenoon two dogs corresponding to those described as the ones found among the cattle in pasture D were seen worrying the stock in Mr. St. Jamin's pasture. In this case they were seen to confine their attack to two yearling heifers,while little attention was paid to the older animals. Mr. St. Jamin or some of the men about the place, seeing that the cattle were being worried, started across the fields towards the pasture,but before they had arrived the dogs had disappeared in the woods. No examination of the heifers was made at that time as at a distance they appeared to be all right. In about two weeks or more they were missed from the herd. Search was made and they were found dead in a wooded part of the pasture. An examination showed that they were bitten about the back parts of the body. In fact, Mr. St. Jamin said, "The tail of one was nearly severed at a point several inches from the free extremity." The exact date of the deaths of the heifers cannot be fixed.

No reliable information was obtained in regard to the appearance of dogs in the pasture of Mr. Crowley. All that is known is, that at about the time the other herds were attacked, dogs were heard in the lower part of this pasture where it is heavily wooded.

The symptoms which developed in Mr. Buffington's heifer were, according to statements of Dr. Etienne and others, identical with those exhibited by the cattle known to have been bitten.

Mr. Cheever has furnished some important facts with reference to the source of one of the dogs which probably figured so prominently in the attacks upon the different herds just referred to, and the possible relations of these attacks to the etiology of the disease.

He says that he had owned since a pup a shepherd dog, about two years of age, with black body and tan colored throat and legs. In the early part of April he was on several occasions seen playing about the buildings with a strange hound. One evening while the cows were being milked in the stable the collie was heard to give a number of short, sharp yells as if in pain. Some one rushed immediately to the stable door and saw the shepherd in the yard, and running off to the north across the fields, the hound with which the shepherd pup had occasionally played. As the shepherd did not appear to be much hurt, nothing more was thought of the occurrence for some time.

The collie was generally used to assist Mr. Cheever in driving his cattle from the pasture to the stable, and frequently when an animal was inclined to loiter, would nip its heels or tail, the latter part was most frequently chosen as the point of attack and the owner has said that the dog would occasionally for amusement nip off a few inches of the ends of the tails of the young calves when they were tied in the stable. Judging from the fact that many of the younger animals upon his farm are minus a large part of the free extremity of that important and useful organ,we are inclined to believe that nearly all were subjected several times to the operation.

It was customary for the dog to stay in the house at night,and he was allowed the liberty of the kitchen and adjoining bed-room which was occupied by Mr. and Mrs. Cheever and some of the children. He usually lay during a greater part of the night in one particular spot and rarely moved from it until morning.

Sometime about three weeks after the dog was supposed to have been bitten by the hound, it was noticed that he acted in an unnatural manner. He became lazy and stupid, appeared to suffer slight pain when made to move and had the appearance of being sore and stiff. His appetite became impaired, he was dainty and refused his usual food. He frequently fought the cat with which he was usually on the best of terms. He became affectionate, this was shown by his licking the hands of the children and occasionally attempting to get upon the beds at night, a thing which he rarely tried, and which he was never allowed to do. During the day he would remain about the buildings, lying in dark or shaded places. Usually he was ready to go to the pasture to assist in driving the cows to the stable, but at this time he seemed to have lost his interest and would go only when urged.

His disinclination in this respect became more and more noticeable, although this with his unusual actions did not impress the people about the place as being an indication of anything of a serious nature. Early in the morning of May eleventh the dog disappeared and has not been seen or heard of since, unless he was one of the two dogs found among the herds in the pastures of Miss Howe, Mr. St. Jamin and the one belonging to the town. That he may have been the shepherd described by those who saw the dogs in the pastures is fair to suppose, as their description would answer very closely to his.

No trace of the second dog described as a yellowish brown, medium sized animal has ever been found. No one seen has been able to give any information in regard to the ownership or loss of such an animal.

There appear below in tabulated form the dates upon which the different herds were attacked by the dogs, the number of animals lost by each party, the date when the animals were first noticed ailing and the time of their death. Also the periods of incubation and the duration of the disease.

Animals owned by	No.	Date of attack by dogs	When first taken sick	Date of death	Period of Incubation	Duration
Mary Howe.	1	May 11, 1894	First found June 2	June 3	22 (?) days	1 (?) day
	2	“ “ “	June 3	“ 4	23 days	1 “
	3	“ “ “	“ 3	“ 5	23 “	2 days
	4	“ “ “	“ 4	“ 7	24 “	3 “
	5	“ “ “	“ 4	“ 8	24 “	4 “
	6	“ “ “	“ 9	“ 12	29 “	3 “
	7	“ “ “	“ 5	“ 12	25 “	7 “
Town.	1	May 11, 1894	June 1	June 4 Killed	21 “	3+ “
	2	“ “ “	“ 9	“ 11 “	29 “	2+ “
	3	“ “ “	“ 26	“ 29 “	47 “	3+ “
	4	“ “ “	July 18	July 21 “	68 “	3+ “
Mr. St. Jamin.	1	May 11, 1894	Not known.	Found dead in the pasture two or three weeks after having been chased by dogs.		
	2	“ “ “				
Mr. Buffington. It was kept in Mr. Crowley's pasture.	1	Not known.	June 8	June 10 Killed		2+ “
Perry Cheever.	1	Frequently bitten while being driven from the pasture to the stable.	June 3	June 6		3 “
	2		Calf 10 months old found dead in pasture.			
	3		June 6	June 10		4 “
	4		“ 6	“ 9		3 “
	5		“ 9	“ 10		1 “
	6		“ 15	June 18 nearly dead		3+ “

A study of the table shows that there occurred in five different herds the death of twenty animals. In all but one case, that of Mr. Buffington's heifer, it was known that the individual animals were bitten by dogs or were in herds which were attacked by them. In almost every instance, at the time of death, it was possible to detect recent scratch-like scars either upon the hips, the legs or tail.

In thirteen cases we have the exact dates upon which the herds were attacked by the two dogs,and in eleven of these the exact date when the different animals began to show signs of illness. Assuming that the four animals upon the town farm would have lived only a part of a day which was the case, according to the statement of Mr. Perkins, the superintendent, we have the period of duration of the sickness in eleven of the thirteen cases.

Of Mr. Cheever's animals it is impossible to state the date upon which any particular one was bitten,but we know that all were driven and frequently bitten by his dog previous to his disappearance. With animal number two, the ten months old calf, no reliable information can be given except that it was known to have been with the other cattle several days before being found dead in the pasture.

Animal No. 5 of the same herd (a Jersey cow) when first found on June ninth in a swamp in the pasture presented the symptoms usually observed in animals that had been sick two or three days.

The other four were discovered when first taken ill.

Taking the time that elapsed between the attacks made by the dogs upon the herds and the appearance of the first symptoms as the period of incubation, we find the longest to be sixty-eight days, the shortest twenty-one days with an average of thirty and five-elevenths days.

Leaving out of the calculation the last two animals of lot No. 2 where the periods of incubation are much longer than with any of the others,we find that with the first nine the average period was twenty-four and four-ninths days which more nearly represents the average time.

The period of duration varied from one to seven days. The longest is noticed in No. 7 of lot No. 1. The shortest of which we are positive was No. 2 of the same lot, that being one day. The average of seventeen deaths was nearly three days. This is allowing that No. 9 of Mr. Cheever's herd was taken sick June ninth and died the tenth, and No. 1 of Miss Howe's was taken ill June second and died the third.

It appears that the period of incubation varied more than the duration which ranged within very narrow limits.

To detect if possible the presence of micro-organisms in the blood of animals dead with the disease, on June eighth at the time of making the autopsy numerous stab and surface inoculations were made with the blood from the heart, liver, lungs and spleen upon gelatine Agar-agar and potatoes. Afterwards some were placed in the incubator, others were kept at ordinary room temperature. In all the results were negative.

Suspecting that the attacks of the dogs upon the cattle were accountable for the outbreak of this obscure malady, certain experiments which are given below were made with a view to ascertain the relation of the bites of the dogs to the etiology of the disease.

Two young, full grown rabbits were selected for the first experiment. On June ninth at five o'clock P. M. No. 1 received the following treatment. After being properly secured, the hair clipped from the forehead. it was rendered insensible by the use of chloroform. A small incision about one inch long was made about one-eighth of an inch to the right of the median line of the skull, starting at a point about the level of the eyes. After removing the periosteum a small circular opening was made through the skull which exposed the covering of the brain beneath.

A mixture, composed of a small piece (about the size of a buckshot) of the medulla of the brain of the cow examined the day before, thoroughly broken up in distilled sterile water, was made. By the use of a small, sterile, hypodermic syringe, 0.1 c. c. of this mixture was injected beneath the dura-mater. After this operation the part was carefully cleansed with a one per cent solution of carbolic acid, and the edges of the skin brought together by silk sutures. Then the parts were thoroughly wet in a five per cent solution of carbolic acid. After recovering from the effects of the anaesthetic the rabbit was returned to his cage, and within a short time was eating and appeared as if nothing had happened.

In the case of rabbit No. 2 the hair was cut from a spot about the size of a twenty-five cent piece over the left thigh. The surface skin was then treated with a solution of corrosive sublimate (one to one thousand), after which with a sterilized scalpel an incision about one-half inch in length was made in it. Below and continuous with the incision the skin was separated from the cellular tissue beneath, in such a way that a pouch about one-half inch in depth was formed.

Into this there was inserted a piece of the medulla of the cow's brain about the size of a small pea. The free edge of the skin was then returned to its place and the parts treated with an antiseptic solution. This wound healed firmly by the first intention. No evidence of suppuration ever appeared.

In obtaining the parts of the cow's brain for use, they were in every instance cut and handled with sterilized instruments.

These rabbits were kept in separate cages and daily supplied with water, and food which consisted of a mixture of grain composed of wheat bran, oats and corn, and green food of either clover or plantain leaves.

On the morning of June twenty-seventh rabbit No. 1 was noticed to be ailing. He refused food and was inclined to remain quiet, crouched in one corner of his cage. On the following day his condition was even worse; he remained nearly motionless during the whole time in the corner and it was with difficulty that he could be made to move. A progressive paralysis appeared in the posterior extremities and later it extended to the anterior portions of the body. This paralysis became so severe that the animal was unable to use its legs sufficiently to move about the cage for a few hours before its death. On the afternoon of June twenty-ninth he died. An autopsy the next day showed that the opening in the skull had healed perfectly and that there was no alteration in the structure of the brain or its coverings at the point of injection. All the organs of the body were normal.

The brain and a part of the spinal cord were removed and a small portion of the medulla taken with sterilized instruments, broken up and mixed with distilled sterile water. At two o'clock P. M. June thirtieth, No. 3 was selected and after clipping the hair from the skin above the right eye and cleansing it with an antiseptic solution, an opening was made into the cranial cavity as in the case with No. 1. Then about 0.1 c. c. of the mixture composed of a part of the medulla in water was injected, after which the wound was closed with sutures and treated with antiseptics. It healed at once by first intention.

This rabbit remained well until the morning of July fourteenth when he refused to eat. On the fifteenth he became quiet and was not disposed to move about the cage. On the sixteenth symptoms of paralysis were prominent. On the morning of July seventeenth he was found dead.

The first rabbit inoculated sub dura cerebri with a small quantity of the medulla of the cow first showed symptoms of illness on the eighteenth day following inoculation. Death occurred on the twentieth day.

The rabbit (No. 3) inoculated in the same manner as the first with a part of the medulla of rabbit No. 1 was taken sick upon the fifteenth day and died upon the eighteenth.

There was in the two a difference of three days in the period of incubation, while the time of illness varied a few hours.

At seven-thirty A. M. July thirty-first No. 2 was found ill, and his cage showed signs of his having been violent sometime during the night. At intervals of a few hours during the day he suffered from convulsions which lasted some minutes. During these he would jump about the cage recklessly and violently, occasionally scratching and tearing the litter with his feet. Between the paroxysms he would remain stretched out upon his side or crouched in the corner. At all times he was excitable and the simple approach of a person was sufficient to occasion a convulsion. Death occurred at three-thirty P. M. No post-mortem examinations were made of rabbits Nos. 2 and 3.

It was the intention to have carried the sub-dural inoculative experiments through several more rabbits, but it was not done on account of the unavoidable absence of the writer at the time of the death of animals Nos. 2 and 3.

Taking into consideration the symptoms exhibited by the cows, the period of incubation and duration, the history of an attack by dogs, the fact that no animals were affected except in herds where they were known to have been attacked or bitten by dogs, the experiments with the rabbits in which a shortening of the period of incubation occurred as a result of sub-dural injection of parts of the brain tissue of affected animals, we feel that we are justified in saying that this mysterious disease was genuine Rabies.

I wish to acknowledge the kindness of W. C. Eaton, C. E., for allowing the use of the map used in this bulletin and that of others who have assisted me in various ways.
JAMES B. PAIGE, D. V. S.

POISONING OF CATTLE WITH NITRATE OF SODIUM.

From the fact that large quantities of strong chemicals are being used as fertilizers by our farmers, we believe the case as detailed below is of sufficient interest to warrant its publication, showing what the results may be if they are not carefully handled.

On the thirty-first of last May in company with Dr. J. B. Lindsey, vice-director of the Massachusetts Agricultural Experiment Station, I had occasion to investigate a case in which eleven cows of a herd of fifteen had died as a result of giving nitrate of sodium, in place of chloride of sodium.

The history of the case given by the owner was as follows. The fifteen cows had been in the pasture during the day. Between five and six o'clock in the afternoon they were driven to the stable and all at that time appeared perfectly well.

When in the stable a man, a native of Poland, whose work it was to care for the cattle, gave to all except two what he supposed to be common coarse-fine salt, thoroughly mixed with a small quantity of wheat bran. Two had no bran, but in place had clear salt. So far as is known all of the animals ate heartily of the salt.

About eight o'clock of the same evening the noise made by the cows attracted the attention of one of the men about the place, who upon investigating the cause of the disturbance found that they appeared to be uneasy and to show symptoms of suffering pain. Within an hour or two several had died.

A practitioner of human medicine was called to treat the animals and thinking the trouble due to arsenic prescribed dialized iron, raw eggs, etc. The treatment seemed to avail nothing and before morning eleven of the herd were dead. Of the four which lived, three showed all of the symptons exhibited by those which had died, the fourth did not appear to be affected at all and the question arises as to whether she was given any of the salt as none was found in or about her manger the following day.

The symptoms exhibited by the affected animals, according to the statement of the physician, were evidence of severe abdominal pain, throwing the head from side to side, continual stepping, whisking of the tail, later twitching of the muscles followed by paralysis of the posterior parts of the body, falling, inability to rise when down, resting of the head upon the sides and occasionally pressure of the nose upon the ground. In nearly all of the cases the anus and vulva became swollen and dark in color. In some, purgation existed with frequent straining; faeces thin but not colored with blood were passed. In none was diuresis a marked symptom. Shortly before death the respiration was hurried and labored, especially so in some. In general the symptoms indicated intense abdominal pain, dyspnœa and paralysis, particularly of the posterior extremities.

On the day following the eating of the salt, the three living cows that had during the night shown the same symptoms as those which had died did not appear to be suffering to any great extent. An examination showed the temperature to be only slightly elevated, the pulse nearly normal, the mucous membrane but little injected. Food was refused by all. While the faeces passed were thin and watery they were not abnormally abundant, neither were the functions of the kidneys disturbed to any extent. Slight muscular weakness or paralysis existed in the posterior extremities. So far as known the recovery of these animals was complete.

Autopsies made the following afternoon, (eighteen hours after death) upon two of the cows which had died first and had not been given drugs revealed the following condition. Parts of the mucous membrane of the rectum and of the vagina were everted and swollen and of a bluish black color. Upon opening the abdominal cavity numerous ecchymotic spots were found on the peritoneum and viscera. The mucous membrane of the first and second stomachs near the œsophagus was thickened and red in color, and in these parts it was easily detached from the tissues beneath.

The lungs were semi-solid, dark in color and the blood-vessels filled with dark blood. Scrapings from a cut section showed the presence of air in the air cells. The left side of the heart contained but little blood, while in the cavities of the right large, black semi-fluid clots were found. All other organs of the body were normal.

The condition of the heart and lungs found upon post-mortem examination would indicate that death resulted from asphyxia.

A chemical examination by Dr. Lindsey of samples of material collected from the mangers, from a pail partly filled with a mixture of bran and salt that had been taken from the mangers, from the ground near the pig-pen and barn door, from a box in a shed near by and from a barrel in the same shed in which the nitrate of sodium was kept, showed in every sample the presence of large quantities of nitrate of soda but no chloride of sodium.

A chemical examination of a part of the contents of the stomach failed to reveal a trace of arsenic, lead or other mineral poisons.

In the *Veterinarian* for 1876, there are several articles translated from the *Archives Veterinaires* by Professor Tuson reporting cases similar to this.

One was that of a horse that had drunk ten and one-half pints of a solution of nitrate of soda containing twenty-five and three-fourths ounces of the salt. This animal was seen six hours after taking the soda in solution and it presented many of the symptoms noticed in these cattle. The administration of strong infusions of coffee and alcohol and irritant clysters relieved the animal,and in a few days he completely recovered from the effects of the poisonous salt.

The second case was that of a five-year-old gelding that had drunk from a pool in which nitrate of soda bags had been washed ; he showed the same symptoms and responded to the same treatment as the animal just mentioned.

In the third case a four-year-old mare drank ten and one-half pints of a solution of nitrate of soda, containing between seventeen and one-half and twenty-one ounces of the salt. In a few hours she was attacked with violent colic, which was relieved by the use of clysters of coffee and alcohol. She made a good recovery.

In the second article published there are recorded cases of poisoning among cattle from nitrate of soda. Four bags of nitrate of soda had been placed at equal distances on a grass field and had been allowed to remain there about five hours before being applied. During the time some of the salt had become washed from the bags upon the ground by a slight fall of rain. Three days afterward the cows were turned into the pasture and obtained the salt by licking it from the ground where the bags had been. They afterward showed symptoms of poisoning.

The last case reported in these articles is as follows. " Two hundred bags which had contained nitrate of soda were washed in four large tubs full of water, close to which the cattle passed on the way to the meadows. At about nine A. M. forty-six cows and heifers drank of this solution of the nitrate. . . . At three P. M. the forty-six cows and heifers returned to the farm. At four P. M. a heifer died suddenly and at five P. M. another heifer succumbed."

Although the death of only two heifers occurred, many of the other cattle that drank of the soda solution showed marked symptoms of its effects. The death of these two is accounted for by the writer from the fact that they were the first ones to leave the stable, consequently had more time to drink at the tubs than did any of the other animals which followed.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS
AGRICULTURAL COLLEGE.

BULLETIN No. 28.

CANKER WORMS, ARMY WORM, CORN WORM,
RED HUMPED APPLE TREE CATERPILLAR,
ANTIOPA BUTTERFLY,
CURRANT STEM-GIRDLER,
IMPORTED ELM BARK LOUSE,
GREENHOUSE ORTHEZIA.

APRIL, 1895.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE
1895.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Charles H. Fernald, Ph. D.,	*Entomologist.* *Meteorologist.*
William M. Shepardson, B. Sc.,	*Assistant Horticulturist.*
Malcolm A. Carpenter, B. Sc.,	*Assistant Horticulturist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Charles P. Lounsbury, B. Sc.	*Assistant Entomologist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,
Amherst, Mass.

Division of Entomology.

CHARLES P. LOUNSBURY.

CANKER WORMS.

Canker worms have been becoming more and more abundant for several years in the eastern part of the State, and in the Connecticut Valley after eight or nine years of comparative scarcity, they have again become excessively numerous. Last season they destroyed fully half of the foliage of the apple trees in some places, besides committing extensive depredations on the elms, and there is every prospect of their doing immense damage during the coming spring in all places where active measures are not at once taken to hold them in check.

Two distinct species of insects are included under the common name "Canker Worm," and both of these occur in Massachusetts. They are *Paleacrita vernata* (Peck.) and *Anisopteryx pometaria* Harr. The former is popularly designated "The Spring Canker Worm," and the latter, "The Fall Canker Worm." The seasonal reference is to the appearance of the moths, the caterpillars of the two species appearing simultaneously in the spring. The two species resemble each other so closely in many respects that they were long confounded and regarded as one species. The food plants of the two are the same. Both prefer apple and elm, but will feed also on cherry and peach. The spring species has in addition been reported as feeding on pear, plum, maple, linden, ash, and honey-locust. The male moths of both species are winged, while the females are wingless. The duration of the caterpillar state and the habits of the caterpillars spinning down from the trees when disturbed and when fully grown are the same in the two species.

The life history of the two in many regards is, however, so entirely different, that, to understand clearly how to most economically combat them, it is quite necessary to know with which species one has to deal. We therefore give the round of life of the two species separately, and afterwards call attention to the chief distinction between them in the different stages.

THE SPRING CANKER WORM.

Paleacrita vernata (Peck.).

This species is probably the more common of the two all through the State. The moths begin to issue from the ground as soon as the snow melts in the spring and continue to emerge all through April, the greater part appearing about the middle of this month. In exceptional cases a few may come out in November or on warm days during the winter.

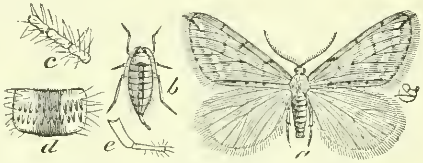


FIG. 1.—SPRING CANKER WORM.
a, Male moth; *b*, female moth, natural size; *c*, joints of her antennæ; *d*, joint of her abdomen showing the spines; *e*, her ovipositor, enlarged. (After Riley.)

The wingless females (Fig. 1, *b*) crawl up the trunks of trees most actively in the evening, when they pair with the males (Fig. 1, *a*) which are flying about at that time. After pairing they lay their eggs. These are deposited in irregular clusters of varying numbers in crevices of the bark or even in expanding buds by means of the long ovipositor (Fig. 1, *e*). The eggs (Fig. 2, *b*) are yellowish, oval in outline, and are about one-thirtieth of an inch in length. They hatch in about three weeks, and the young begin to feed as the leaves expand.

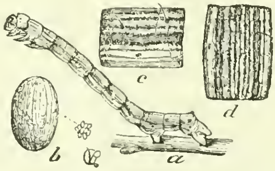


FIG. 2.—SPRING CANKER WORM.
a, Full grown larva; *b*, egg, enlarged, the natural size shown in the small mass at one side; *c*, an enlarged joint, side view; *d*, the same, back view, showing the markings. (After Riley.)

The caterpillars feed about four weeks, completing their growth in this State about the middle of June. They have three pairs of true legs, situated on the three segments following the head, and two pairs of prolegs. They move by alternately looping and extending their bodies, as is the case with the caterpillars of the Fall Canker Worm, and also of those of the other species of the same family. When fully grown (Fig. 2, *a*) they are from three-quarters of an inch to an inch in length, variable in general color, though most frequently brownish, with eight scarcely noticeable lines of a lighter hue running lengthwise (Fig. 2, *d*), and with the head and back marked and spotted with black. At maturity they descend to the ground by means of the silken thread which they spin, and burrow to the depth of three inches or more where they construct fragile cocoons of a dull yellowish color within which they pupate in a few days. They remain through the winter in this state.

The male moth (Fig. 1, *a*) is of a pale ash color with a paler broken band across the forewings near the outer margin, and three interrupted brownish lines between that and the base. The hind wings are of a very pale ash color or very light gray and generally have a darker dot near the middle. The female (Fig. 1, *b*) is grayish in color with a black stripe along the middle of the abdomen. The first seven abdominal segments of both sexes are crossed by two transverse rows of short, stiff, reddish spines which point backwards; they are largest in the females (Fig. 1, *d*).

THE FALL CANKER WORM.

Anisopteryx pometaria Harr.

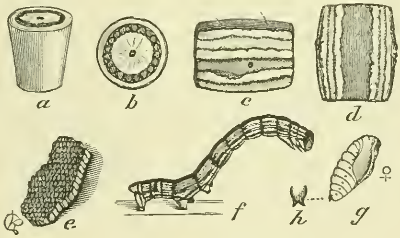


FIG. 3.—FALE CANKER WORM.
a, *b*, Egg, side and top views; *c*, *d*, joints of larva, side and top views, showing markings, enlarged; *e*, cluster of eggs; *f*, full-grown larva; *g*, female pupa, natural size. (After Riley.)

This species is very common in eastern Massachusetts, but has not been observed in Amherst. Most of the moths emerge from the ground late in the fall, occurring in the greatest numbers in November, but many come out earlier and a few remain in the ground over winter. The female ascends the tree attended by the males, but instead of depositing its eggs (Fig. 3, *a*, *b* and *e*) in sheltered places as the other species does, it lays them in an exposed situation in a compact, regular cluster, in a single layer of 200 or more. The egg is in the form of a truncated cone and is attached by the smaller end. The opposite end has a depressed centre and is bordered by a dark circle. The general color of the eggs is grayish.

The eggs hatch in the spring with the unfolding of the leaves. The caterpillars resemble those of the other species in habits, and as in that species, the young are most often greenish. The mature caterpillars measure almost an inch in length. As in the other species, the body is longitudinally striped, but instead of eight indistinct stripes, there are six distinct ones. And instead of but two pairs of prolegs, this species has three (Fig. 3, *f*), the additional pair being small but distinct.

When through feeding the caterpillars descend from the trees and burrow into the ground. Here they construct dense, buff-colored cocoons within which they pupate about a month later.

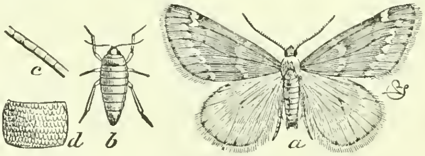


FIG. 4.—FALL CANKER WORM.

a, Male moth; *b*, female moth, natural size; *c*, joints of her antennæ; *d*, joints of her abdomen, enlarged. (After Riley.)

The male moth (Fig. 4, *a*) is of a pale gray or ash color. The fore wings are crossed by two rather irregular whitish bands, and the hind wings by a single, less distinct whitish band. The female (Fig. 4, *b*) is of a uniform pale gray or ash color. Neither male nor female has spines along the abdomen.

MARKED DISTINCTIONS BETWEEN THE TWO SPECIES.

Most of the Spring Canker Worm moths emerge in the spring, while most of the Fall Canker Worm moths come up in the fall.

The eggs of the spring species are oval in outline and are laid in sheltered situations in irregular clusters. The eggs of the fall species are in the form of a truncated cone and are laid in exposed places in regular clusters.

The caterpillars of the spring species have but two pairs of abdominal legs, while those of the fall species have three.

The first seven abdominal segments of both sexes of the moth of the spring species bear two transverse rows of short, stiff, reddish spines which point backwards. The abdomen of both sexes of the fall species is concolorous and without spines.

REMEDIES.

Most of the means used to hold the Canker Worm in check are based on the wingless condition of the female, and the fact that it passes its transformations in the ground. These consist of obstructions of various kinds placed about the trunks of the trees to prevent the ascent of the females and likewise of the young caterpillars if the eggs are laid below.

Paper Bands.—The method in most general use is to paint belts of paper fastened about the trunks of trees with some sticky substance such as printer's ink or tar softened with oil. The use of the paper is to prevent injury to the bark. As the efficiency of this method depends entirely upon its thoroughness, great care should be taken not to leave the slightest crevice between the band and the bark through which the moth or the exceedingly small, newly-hatched larva might find its way, and equal care should be observed to keep the band constantly moist and also to prevent the encumbered moths from becoming numerous enough to cover the band and thus bridge it for the next comers.

That the band should be perfect, the following procedure is advised: First scrape or cut away the bark in a ring a few inches wide about the trunk until it is fairly smooth, taking care not to cut deep enough to injure the cambium which is that part between the bark and the wood. Then bind a strip of cotton waste or batting about this smooth portion. Cover this with a strip of paper seven or eight inches in width, secured in position by numerous tacks along the edges or by a stout cord bound tightly about the middle. Finally apply a liberal coating of the sticky substance to be used about the middle of the paper.

In the orchard it matters little at what height the trees are banded, but along highways it is best that the bands be placed at a height sufficient to keep passers-by from coming in contact with them.

Tarred paper, the kind best suited for tree-bands, is sold by dealers in agricultural wares, from whom, also, preparations for painting the bands can be procured.

Raupen-leim.—For several years a preparation of tree-ink superior to those used in America has been extensively used in Germany. This preparation, known as "Raupen-leim," has the advantages of not being injurious when applied directly to the bark, and of remaining sticky for many weeks, much longer than the substances ordinarily used. The Gypsy Moth Committee in their work of exterminating the Gypsy Moth in eastern Massachusetts have imported several tons of it, and have found it much more economical to use than the preparations previously employed.

"Raupen-leim" is now being placed on the American market under the name of "Insect Lime," and we have received circulars advertising it from Wm. Menzel & Son, 64 Broad street, New York, N. Y. The Bowker Fertilizer Company, 43 Chatham street, Boston, Mass., has also made arrangements to furnish it.

Tree Protectors, Traps, etc. — Besides the simple methods of banding, numerous contrivances known as Canker Worm traps and tree protectors are often made use of. They consist of a trough to contain an oily liquid, protected by a roof of some sort, so secured about the trunk that no insect can pass. If proper precautions are taken to leave no crevices when putting them on and to keep the trough filled with oil and free from extraneous matter, they are a sure protection and at the same time less troublesome to care for than the ordinary bands. On account of their costliness, however, they are little used except on ornamental trees on private estates where appearances are of more import than economy.

Cotton Bands.—Cotton batting in strips about four inches wide, tied securely about the trunk, has been found by Miss Mary E. Murtfeldt* to be a cheap and effective barrier to the moths. The insects become entangled in the fibres and die from exhaustion. The bands should be examined every two or three days and the eggs and living moths crushed. This kind of barrier, if kept on through the winter, would probably need to be renewed or at least combed out in the spring. It should also be frequently examined to see that it has not become torn or blown away.

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* U. S. Dept. Agr. Report, 1888, page 138.

Whatever the style of barrier used, it is always best where the insects are very numerous, to destroy the eggs deposited below the bands. This is not a necessity but it is a wise precaution, for often the bands may not be absolutely "worm-proof." Perhaps the surest way to destroy the eggs is to carefully scrape the bark and burn the scrapings, but an application of kerosene is effective though apt to injure young trees. The time to destroy the eggs is just before they are expected to hatch, in this State during the first week of May.

Time to Apply Bands.—If it is known positively that only the Spring Canker Worm is to be contended with, the bands need be kept moistened through March, April and May only, but if the Fall Canker Worm is the pest, the bands should also be kept moistened throughout October and November. If there is doubt as to which species it is, it is best to have the bands in readiness in the fall on all the trees, but to apply the ink on a few only. A close watch should be kept on this few and if any moths are found caught, the bands on all the trees should be immediately inked.

Arsenical Sprays.—Showering with arsenical sprays is the most effectual method of destroying the caterpillars on trees which have not been protected by bands, and on those on which, through lack of proper care, the bands have proved ineffectual.

For this purpose Paris green, London purple, or arsenate of lead may be used. One pound of Paris green to 150–200 gallons of water is a safe proportion if the liquid is kept well agitated to keep the poison in suspension. London purple is a less powerful poison than Paris green and more liable to injure the foliage, but it has the advantage of being cheaper. It should not be applied stronger than one pound to 150 gallons of water. With arsenate of lead properly prepared there is absolutely no danger of injuring the foliage, no matter how strong the mixture. Arsenate of lead can be prepared by bringing together eleven ounces of acetate of lead and four ounces of arsenate of soda in water. These substances dissolve and unite with each other to form arsenate of lead, a fine, white powder which remains in suspension much longer than Paris green. If the materials are lumpy they should be crushed to a powdered condition before being put in the water. Hot water should be used to dissolve them. Two pounds of arsenate of lead to 150 gallons of water is a good proportion to use.

All arsenical poisons should be applied in the form of a very fine spray. They will remain on the foliage much longer if two quarts of glucose, or if that substance cannot be obtained, two quarts of molasses, are added to each 150 gallons of water. The spraying should preferably be done when the caterpillars are young, before the end of May. A second spraying is often necessary in case of heavy rains or if the trees are very badly infested. For trees with tender foliage, as the peach and plum, the proportion of Paris green or of London purple should not be greater than one pound to 250 gallons of water.

THE ARMY WORM.

Leucania unipuncta (Haw.).

During the past year two outbreaks of this old-time pest were reported in this State, one in Franklin County and the other on Cape Cod. The numbers of the Army Worm in any one year depend largely upon certain climatic conditions, which, happily, are seldom fulfilled. Whether or not the conditions have been sufficiently fulfilled to ensure a general outbreak this year is doubtful, but lest they may have been, the following account of the habits of the caterpillar and of the means best adapted to prevent or check its ravages is given in order that the farmers of the State may not be altogether unprepared.

The normal feeding grounds of the Army Worm are in swamps or low meadows where it subsists upon the various kinds of grasses and sedges. Here with habits very similar to those of the common cutworms, to which it is allied, it escapes the common notice. But when the caterpillars become exceedingly numerous and their food supply is insufficient for their needs, they develop the trait which has suggested their common name, that of marching in armies. Then they appear as if by magic, marching in straight lines across the neighboring lands, stripping the fields clean of everything agreeable to them, and often doing immense damage by cutting off plants not satisfying to their ravenous appetites. This march they keep up until they have completed their growth or are checked by outside agencies.

The eggs (Fig. 5) are glistening-white in color, nearly globular, and are stuck in rows of from 15 to 20 on blades of grass, generally being hidden under a fold of a leaf or between the sheath and the stem. Frequently they are deposited in stacks of standing straw, hayricks and the like. The number laid by a single female varies from 500 to 750.

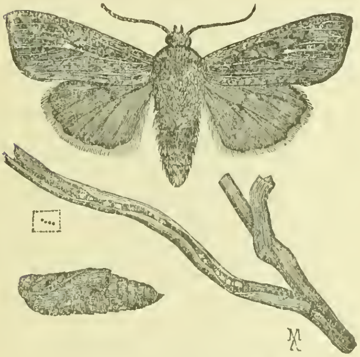


FIG. 5.—ARMY WORM.
Moth, eggs, and pupa. (From Dept. Agr. Report, 1879.)

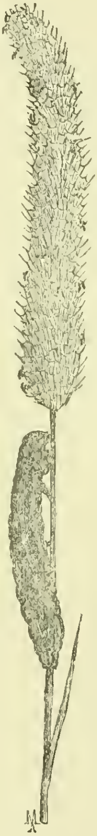


FIG 6.—ARMY WORM.
Caterpillar. (From Dept. Agr. Report, 1879.)

The full grown caterpillar (Fig. 6) measures about one and one-half inches in length and a trifle less than one-quarter of an inch in diameter. The body is dingy black in color and bears a few, short scattered hairs. Along the sides of the back are two narrow white lines extending the whole length of the body; a third white line begins at the head between the other two, but after extending a short distance backwards it becomes very faint and almost lost in an indistinct deep black stripe which reaches to the end of the body. Below the first-mentioned white line comes a rust-colored stripe which is so mottled with black that it does not show very plainly; below this is a fine white line; then comes a broad black stripe and below it a prominent dull reddish stripe bordered above and below with white. The under surface is more or less greenish. The head is nearly as large around as the body, and has two black lines from the top down toward the mouth. There are sixteen legs in all and those from the middle of the body are each marked with a shining black band. The young caterpillars feed mostly in the night, but later in life they can be found feeding during the day. When disturbed they curl themselves like cut-worms and drop suddenly to the ground, often from quite a height.

After completing its growth which requires about a month, the caterpillar burrows an inch or two into the ground or conceals itself in rubbish and soon changes to a mahogany brown pupa. (Fig. 5.) In from two to three weeks the moth emerges. The moth (Fig. 5) is of a light reddish-brown or dark fawn color, and is of much the same general shape and size as most cut-worm moths, measuring about one and three-quarters inches across when the wings are outspread. One can quickly recognize it by a small white spot near the centre of each fore wing and by an oblique dash of black extending from the outer front border of the wing toward this white spot. The hind wings are dusky in color and are almost black near the outer margin; on the under side they have a distinct black spot near the middle. The moths are nocturnal in their habits, fly rapidly, and rarely ascend more than a few feet from the ground.

The number of annual broods and the mode of hibernation of the Army Worm varies in different parts of the country. Heretofore it has been generally accepted that in Massachusetts there were two broods and that the winter was passed as a partly grown caterpillar; but the observations of the past year tend to dispute both of these conclusions, at least in so far as the Cape Cod cranberry bogs are concerned, where, however, the conditions are somewhat abnormal. On the Cape the caterpillars were first noticed on dates varying from June 20th to July 1st on bogs which had been covered with water up to June 1st—June 10th. They were then very small, and in nearly every case were observed to come from among the moss, rushes and other foreign growth along the ditches. From these places they spread over the bogs, feeding on the rushes, sedges and certain of the weeds, and cutting off the new growth of the cranberry vines. On July 7th—10th they varied in length from one-half to one and one-quarter inches.

On July 1st caterpillars were noticed in large numbers at South Deerfield, and on July 9th these varied from one inch to one and one-half inches. Caterpillars from both Cape Cod and South Deerfield, reared at the Insectary, went into the pupal stage about July 17th and the moths emerged August 4th. Moths were numerous (at sugar) in Amherst from July 28th all through August, and a few were caught in early September.

There is no probability of there having been a brood preceding the one observed on the bogs, but, though it seems unlikely, there may have been one at South Deerfield: in which case, the simultaneous appearance of the caterpillars in the two places is merely a coincidence.

The brief period elapsing from the drawing off of the water to the maturity of the caterpillars on the bogs precludes the possibility of the insect having hibernated in the moth or pupal stages; and the small size of the caterpillars when noticed, their coming from very restricted places in such immense numbers, and the fact that the bogs were under water up to so late a date, which seemingly would drown out the caterpillars, makes it more plausible that the winter was passed in the egg than in the larval stage. In whichever of the latter stages the hibernation occurred, the deposition of the eggs must have taken place before mid-winter when the bogs became completely submerged.

The moths which emerged August 4th were from the largest caterpillars sent to the Insectary, and the probabilities are that the bulk of the moths did not appear until the middle of the month. In fact, the superintendent of one of the largest infested cranberry bogs states that the caterpillars were not through feeding until August 15th. The females fly two weeks at least before beginning to deposit their eggs and two weeks more are required for these eggs to develop; consequently few could have hatched before the middle of September, and as the growth of the caterpillars at this season of the year would necessarily be slow, the chances are very much against a second brood passing through all its transformations. The natural inference, then, is that the eggs (or young larvæ) which pass the winter arise from the summer brood.

REMEDIAL MEASURES.

On the upland there are many ways of checking the advance of the Army Worm. The simplest of these where the soil is stiff or clayey is to plow a deep furrow around the infested fields with the straight side towards the part to be protected; the caterpillars, not being able to crawl by the furrow, can be easily scraped into holes and buried. If holes be made with a crow-bar at short intervals in the furrow, numbers of the caterpillars will fall into them and may there be crushed with little trouble. In case of very large armies it might be necessary to plow several successive furrows, the earth from each burying the caterpillars trapped in the one before it. Another simple way is to spray the grass ahead of the caterpillars with Paris green, and another to run a heavy roller over the ground. None of these methods would answer on a cranberry bog; the first, because of the nature of the surface, the second because the caterpillars eat so little of the cranberry foliage, and the third because of the wiry nature of the vines. A fourth method, that of placing obstructions in the line of march, is more applicable. These obstructions are best made of planks or fence rails placed on edge, end to end, and close to the ground so as to leave no openings beneath. This barrier is then thickly smeared with coal tar or even kerosene. If care is taken to prevent the caterpillars from piling up even with the top of the boards and thus forming a bridge for those behind, this method proves quite effectual Wide, water-filled ditches on a bog, are, however, the surest means of stopping them, although a few, when the army is very large, may drift across the stream and become lodged on the further side without drowning.

It is a fact often commented on that fields which are burned over in the winter are always quite free from the Army Worm. This is true no matter in which stage the insect hibernates; and as the benefit derived by the destruction of other injurious insects is also very marked, the burning over of grass and waste lands annually deserves to be more generally practiced.

The particular attention of cranberry growers is called to the fact that the eggs are almost invariably laid upon grass-like plants, and that these plants are the normal food of the caterpillars. Therefore, the growers who keep their bogs free from these weeds and their ditches clear of all rushes and sedges are not likely to suffer from the attacks of this pest.

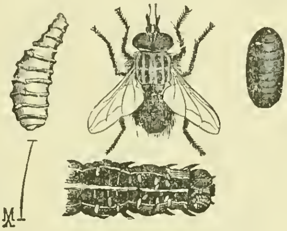


FIG. 7.—ARMY WORM.

Nemoræa leucaniæ, one of the parasites of the Army Worm, showing the larva, puparium, and the adult; also the fore part of a caterpillar showing the eggs of the parasite. (From Dept. Agr. Report, 1879.)

The Army Worm has a large number of natural enemies. It is greedily devoured by poultry and by all insectivorous birds, and frogs and toads find it dainty food. A dozen or more species of predaceous beetles are known to feed upon the caterpillars, and a large proportion of them become parasitized by flies of different kinds. Many of the caterpillars reared at the Insectary yielded friendly Tachina flies instead of moths. The eggs of these flies are almost without exception placed upon the head and thorax. When they hatch, the young maggots bore into the body of the caterpillar and nearly always cause its death. The different stages in the life of the most common one of the parasites is shown in Fig. 7.

THE CORN WORM.

Heliothis armiger (Hbn.).

This pest has for several seasons past been common in Barnstable County, and during the past year was injurious to a marked extent in the towns about Boston. It is not exclusively a corn insect, attacking as it does, a great variety of plants, but in this State it is seldom injurious except to corn and tomatoes.

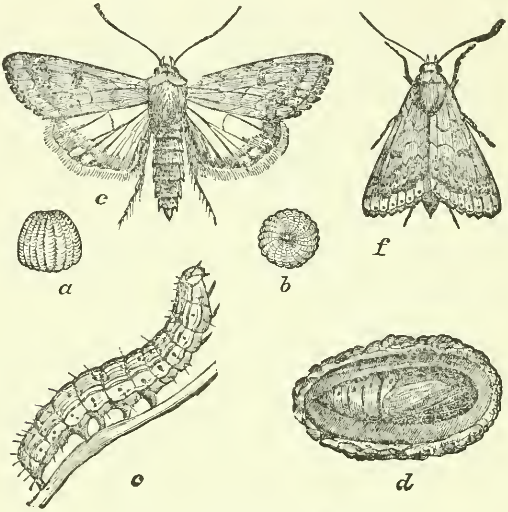


FIG. 8.—THE CORN WORM.

a, Egg, side view; *b*, egg, top view, both greatly enlarged; *c*, caterpillar; *d*, pupa in the cocoon; *e*, moth with the wings spread; *f*, moth with the wings closed, natural size. (After Riley.)

The eggs (Fig. 8, *a* and *b*) are laid singly on various parts of the food plant, and require less than a week to hatch. They are yellowish-white in color and nearly globular. The caterpillar when fully grown (Fig. 8, *c*) in about an inch and a half in length and one-quarter of an inch in diameter. There is little uniformity in color among different individuals, varying as they do from dark brown to light green. Usually the body is striped with darker shades of the general color, and has several white lines on the sides. However inconstant the markings, certain small, shining spots, each crowned by a hair, are always present. These are generally black, and eight occur on the back of most of the segments.

The caterpillars pupate beneath the surface of the ground, and those of the second brood pass the winter in the pupal state. The moth (Fig. 8, *e* and *f*) expands about an inch and a half, and varies in the color of its body and fore wings from yellow to olive green. A prominent dark spot is usually present near the middle of the wing. The hind wings are much lighter colored, with a broad dusky band around the outer margin enclosing a large light spot near the middle.

The damage done by the Corn Worm is chiefly to corn in the ear. The caterpillars gnaw through the husk and devour the kernels. Their injuries cause more or less sap to exude, which, fermenting, often molds and spoils the entire ear. Tomatoes are often found with the caterpillar eating inside of the fruit.

Ploughing infested fields very late in the fall to break the cocoons of the hibernating pupæ and thus expose them to the killing influence of the frost will do much toward keeping this insect in check. The caterpillars in infested ears of corn should be sought for and destroyed.

THE RED HUMPED APPLE TREE CATERPILLAR.

Œdemasia concinna (S. & A.).

This insect is a common one nearly every year, but was more than usually abundant during the past season.

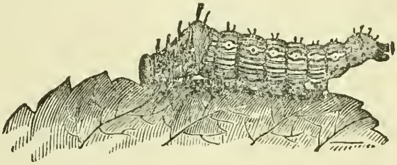
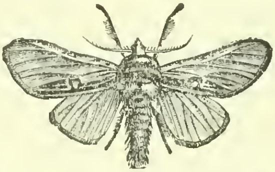


FIG. 9.—RED HUMPED APPLE TREE CATERPILLAR. (After Saunders.)

The eggs are deposited in a cluster of a hundred or more on the under side of a leaf of the food plant during July. The caterpillars are gregarious and when not feeding, rest together in great numbers on the branches. When mature (Fig. 9) they are fully an inch and a quarter in length and quite stout. The body is longitudinally striped with black alternating with yellow or whitish lines. The head is bright red. Blunt, black, hair-tipped spines arranged in a double row occur on the back, the longest being borne on the summit of a prominent. reddish hump arising from the fourth segment; similar but shorter spines occur on the sides. The hindmost pair of legs is not used in walking, and when at rest the last three segments of the body are always elevated.

When young the caterpillars feed only on the under surface of the leaf, but later they devour the entire leaf. At maturity they descend to the ground, and, concealing themselves in rubbish, they spin silken cocoons within which they remain, still in the caterpillar state, until the following May when they change to pupæ from which the moths emerge about the first of July. There is but a single brood in a season, but it frequently happens that some of the moths are late in emerging and so caterpillars in different stages of growth may be found throughout the summer.



FIG, 10.—RED HUMPED APPLE TREE CATERPILLAR MOTH. (After Saunders.)

The moth (Fig. 10) is not a very showy creature and is seldom noticed. It measures about one and one-quarter inches across its expanded wings. The fore wings vary from dark brown near the hinder margin to grayish along the front, and bear several dark spots, the most conspicuous being near the middle. The hind wings are of a lighter shade of brown, often becoming dirty white in the male. The thorax is deep gray with darker shoulder covers and a dark brown patch at the hind border. The abdomen is light brown.

This insect is most troublesome on apple trees, but occurs very frequently on all orchard trees as well as on blackberry and rose bushes and many other shrubs and trees.

As the caterpillars feed in colonies the problem of destroying them is comparatively simple. The branch they are on may be cut off and burned, or by a sudden jarring of the branch the caterpillars may be dislodged and then crushed under-foot. Often times they are attacked by a small Ichneumon fly, and when caterpillars dead from this cause are observed it is well not to disturb them. They are much shortened, grayish in color, and the cocoon of the contained parasite gives them a characteristic bloated appearance. If it were not for this friendly parasite the caterpillars would be much more common than they are.

THE ANTIOPA BUTTERFLY.

Euvanessa antiopa (Linn.).

The caterpillar of this butterfly is one of the most commonly observed defoliators of the elm, and is sent to this station a large number of times every season by persons mistaking it for the caterpillar of the Gypsy Moth, to which, however, it bears only a slight superficial resemblance.

There are two broods of this insect in Massachusetts, the butterflies from the first appearing late in June or early in July, and from the second in the fore part of September. Those of the second brood hibernate and appear again on the wing at the first approach of spring, and by the middle of May have laid the eggs for the first brood.

The pale yellow, ribbed, barrel-shaped eggs to the number of about 200 are laid in a single layer about a terminal twig of the food plant, and hatch in about a week from the date of laying.

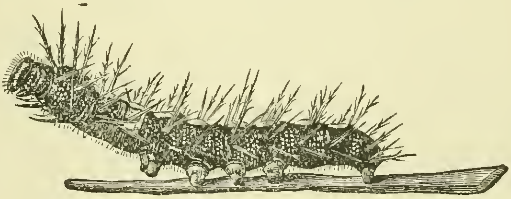


FIG. 11.—ANTIOPA BUTTERFLY CATERPILLAR. (After Scudder.)

The full grown caterpillar (Fig. 11) measures about two inches in length. It is black with very numerous, fine, white markings, and a row of eight large, rounded, prominent, reddish spots along the middle of the back. Four to seven straight, rather long, stout, slightly branched black spines project from each of the body segments. Earlier stages differ somewhat in regard to the spines, but all bear the characteristic row of red spots on the back.

The caterpillars are social in their habits and completely strip the branch they are on before leaving it. After feeding about four weeks the caterpillar changes to a dark brown chrysalis with darker markings about a double row of pointed tubercles on the back. The chrysalis state lasts about two weeks, and then gives rise to the butterfly. The butterfly has purplish-brown wings bordered outwardly by a band of yellow just inside of which is a row of blue spots. Its outspread wings measure from three to three and one-half inches.

Besides the elm the caterpillars feed on willow and poplar and to a slight extent on many other trees.

The social habits of these caterpillars render their depredations conspicuous. The easiest method to destroy them is to trim off infested branches and to burn or crush the insects on them. Spraying with arsenical mixtures is only advisable when the colonies are very numerous.

THE CURRANT STEM-GIRDLER.

Phyllœcus flaviventris (Fitch.).

Currants in different parts of the State have suffered during the past year from the attacks of this insect. The injury inflicted consists in the girdling of the tips of the new growth by the adult insect and the subsequent burrowing in the pith by the larva.

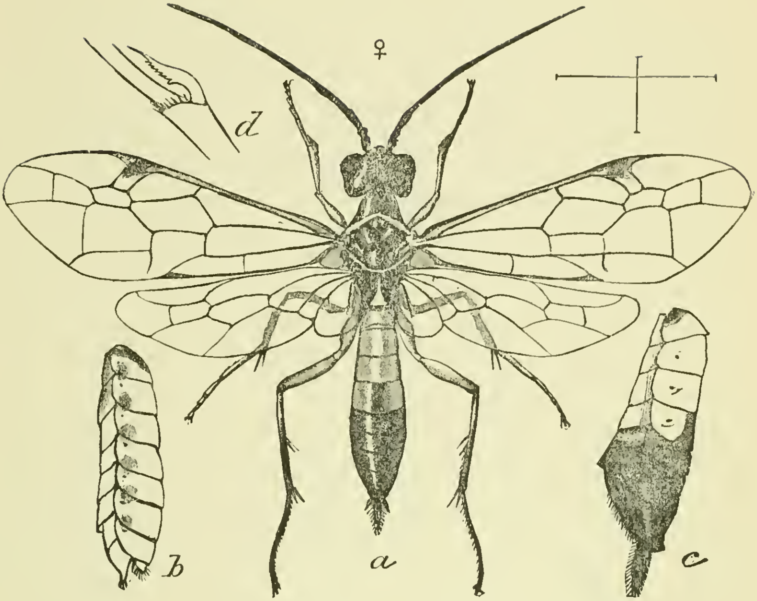


FIG. 12.—CURRANT STEM-GIRDLER.

a, Female; *b*, lateral view of male abdomen; *c*, lateral view of female abdomen; *d*, apex of anterior tibia of the female, showing serrated tibial spine, all enlarged. (From Insect Life.)

The insect is an Hymenopteron belonging to the family Uroceridæ. The adult is a slender-bodied fly. The female (Fig. 12, *a*) measures a little less than one-half inch in length and a little more than three-quarters of an inch across its outspread wings. Its antennæ, head, and thorax are black. The fore and middle pairs of legs are reddish-yellow at the base and dark brown or black on the outer half. Both pairs of wings are transparent and iridescent, and the veins, with the exception of the one along the front margin of the fore wings which is yellowish, are dark brown. The stigma (located on the front margin of the fore wing beyond the middle) is dark smoky brown. The abdomen (Fig. 12, *c*) is blackish at the base and on the outer half, with the intervening part reddish-yellow. At the end is a thick, blunt, black spine, projecting beneath which the saw-like ovipositor may generally be seen. The male is a trifle smaller than the female and differs slightly from it in its colors and markings, but the only conspicuous difference is in the abdomen (Fig. 12, *b*) which, with the exception of the black base and a row of dusky oval spots on the sides, is all reddish-yellow.

The insect appears on the wing during the latter part of May. The female makes a number of curved gashes about the twig a few inches from the tip, generally numerous and deep enough to cause the tip to wither and often to break off, and deposits an egg in the stem an inch or less below the cuts. The larva on hatching from the egg burrows slowly down the stem, feeding on the pith, and reaches its full growth in the autumn. It then spins a thin cocoon in which it hibernates. In the spring it changes to a pupa and then to the adult.

The mature larva* is a glistening, straw-yellow maggot, two-fifths of an inch in length and about one-tenth in width. It is cylindrical in form with a fleshy expansion, constricted between the segments, along the sides; this expansion or ridge gives the larva a broader appearance when viewed from above than from the side. The head is smooth and glistening, slightly darker and not more than half as wide as the body. The mouth parts are dark brown and the mandibles are tipped with black. The thoracic segments are somewhat more swollen than the abdominal ones and bear rudimentary feet. The dorsal vessel shows through the back as a narrow, dark stripe. On the upper side at the end of the thirteenth or last segment is a minute, dark spine. When much magnified this spine is seen to be slightly bifid at the tip and surrounded at the base by smaller spines. A small, round, reddish spot occurs in the middle of the lateral fold on segments seven to twelve inclusive. On either side below the terminal spine is a similarly colored linear marking, and above, immediately in front of the spine, is a short, transverse, more deeply colored marking.

The simplest method to hold this insect in check is to trim off and burn all the canes that have been girdled, two inches or more below the point of injury, as soon as the girdling is noticed. The egg, which, as has been noted, is deposited an inch or less below the girdle, will then be destroyed.

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*No description of the larva, as far as we are aware, has hitherto been published.

THE IMPORTED ELM BARK LOUSE.

Gossyparia ulmi (Geoff.).

This recently imported bark louse was first noticed in Massachusetts about eight years ago and is now very common in many parts of the State on the various species of elms. It has been particularly injurious to Camperdown elms here on the college grounds and is also common on the native species. In the vicinity of Boston, especially in the adjoining towns of Brookline and Brighton, numerous young American elms have been observed in an almost lifeless condition from its exhausting attacks.

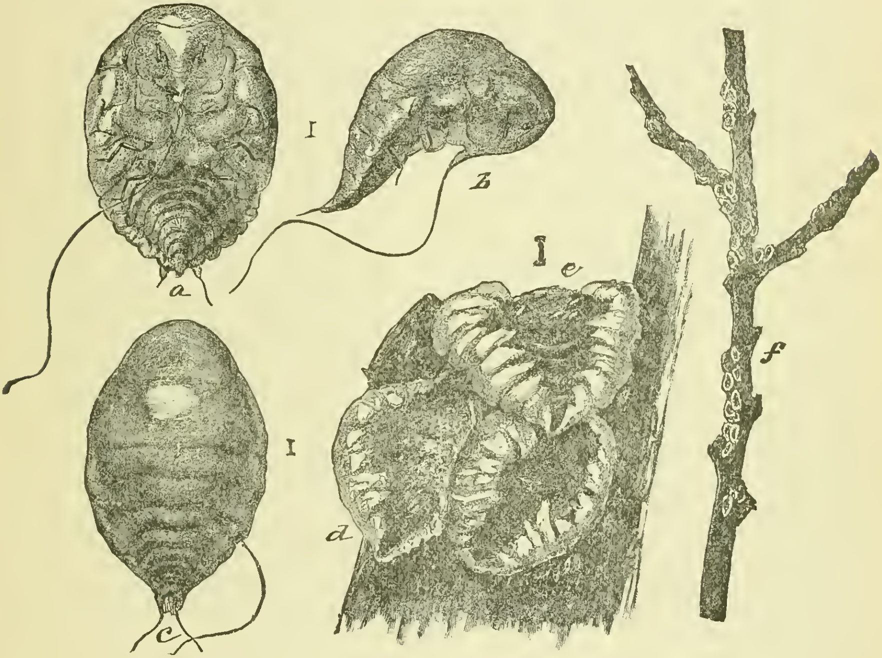

FIG. 13.—IMPORTED ELM BARK LOUSE.

a, Adult female from below; *b*, adult female from side; *c*, adult female from above, all greatly enlarged; *d*, empty waxy cushion; *e*, females in natural condition, enlarged; *f*, shrivelled females, natural size. (From Insect Life.)

In general appearance these bark lice somewhat resemble the common Mealy Bug of the greenhouses. The adult female (Fig. 13) produces a large number of live young during the early summer. The young are yellow in color, exceedingly small and very active. They soon establish themselves all along the underside of the twigs and leaves, where, inserting their long slender beaks into the plant tissues, they imbibe the sap. Late in the summer they leave the terminal growth and return to the trunk and larger branches, seeking shelter as far as possible in crevices of the bark. In this condition they remain over winter. In the spring the females (Fig. 14, *a*) have assumed a reddish hue and after copulation with the males, which occurs late in May, they remain immovably attached to the bark. They now become almost imbedded in a mass of waxy matter (Fig. 13, *d*, *e*, and *f*) which they secrete, and have a peculiar sickening odor when present in large numbers, and when crushed yield a reddish color. At this stage, and to some extent in the late summer and fall, they exude from their bodies a large quantity of honey-dew which falling on the leaves and branches gives these parts a peculiar blackened appearance which is very noticeable where the insects are at all abundant. It also attracts ants and other insects to the trees.

The adult males (Fig. 14, *c*) like those of all other bark lice are very unlike the females in appearance, and when fully developed are provided with a single pair of wings and a pair of very long, wax-covered organs which project from the hinder part of the body.

The injuries inflicted by these insects appear severe only to young trees, large trees, apparently, being much better able to withstand their attacks ; and, as the task of destroying them is a difficult one, efforts in this direction will pay only on young or valuable trees, leaving those on large trees to be cared for by natural enemies. Kerosene emulsion has been used to hold them in check on infested trees about the college. During May and June, this, diluted nine times, was found to diminish their numbers but slightly. At the same strength late in the fall no better results were obtained. As injury to the foliage at this season of the year would not impair the vitality of the tree, the strength of the emulsion was increased first to double, then to triple, and finally to four times its ordinary strength, and until this last strength was used, few of the insects succumbed. This proportion, however, appeared very effective, and has been used during late August, September and October without any observed injury to the trees resulting. All the sprayings were made by Mr. M. A. Carpenter of the Botanical Department and were for results rather than for experiment.

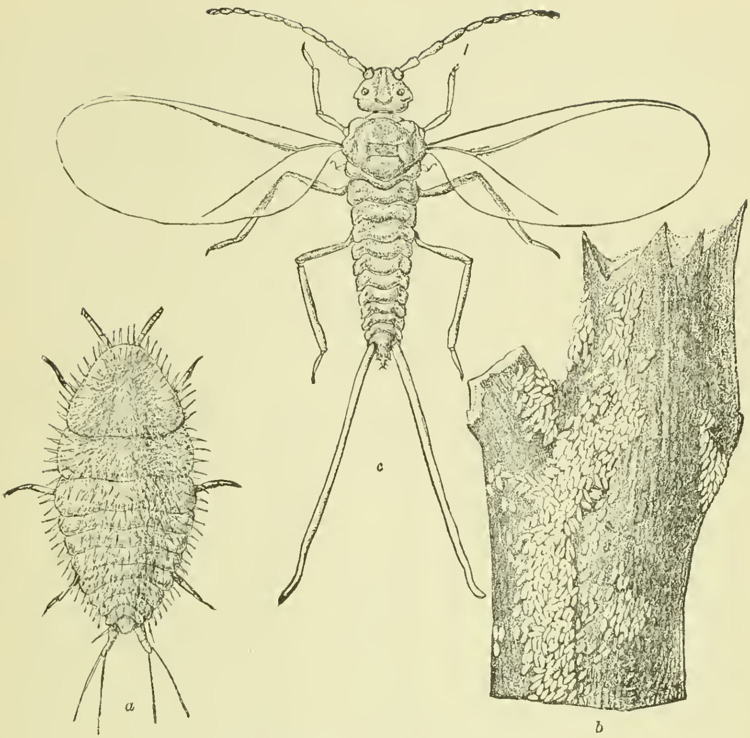

FIG. 14.—IMPORTED ELM BARK LOUSE.

a, Female before impregnation, greatly enlarged; *b*, male cocoons in natural position on limb, natural size; *c*, perfect male, greatly enlarged. (From Insect Life).

It is possible that good results might be obtained by spraying with the emulsion of the ordinary strength during midsummer when the young are very small. Mr. J. H. Bowditch of Brookline reports that he rid some small trees of them by cleaning with a stiff brush, and this method, though laborious, seems quite advisable where only a few young trees are concerned. The brushing should, of course, be performed during the fall or winter when the insects are on the trunk and branches.

The formula usually employed in preparing kerosene emulsion is as follows:

Common bar soap,	½ pound,
Kerosene oil,	2 gallons,
Water.	1 gallon.

Dissolve the soap in boiling water, and, while the solution is still boiling or very hot, add the kerosene. Churn the mixture through a force pump until it emulsifies, which will take about five minutes. For ordinary use dilute the emulsion with nine parts of water. Another method of preparing kerosene emulsion is given in the article on the Greenhouse Orthezia in this bulletin.

THE GREENHOUSE ORTHEZIA.*

Orthezia insignis Doug.

The despicable little insect figured on the accompanying plate is one of the newest pests in greenhouses. It is a tropical insect somewhat closely allied to the common mealy bugs familiar to every florist. It was first brought to notice near New York City about five years ago and has now become very generally disseminated through the adjoining states. In Massachusetts it is most common about Boston.

The Greenhouse Orthezia has its mouth parts formed for piercing and sucking, and obtains its nourishment by imbibing the plant sap, like all other species of the family to which it belongs. The young are very small, and would hardly be discerned on a plant were it not for the presence of snow-white plates of waxy matter which occur on the back and sides, and which contrast strongly with the darker background of the body. The adult females are about the size of the head of a pin and resemble the young in appearance, but bear in addition to the white plates on the back and sides a somewhat cylindrical sac of the same substance, which projects for some distance behind the insect and in which the eggs are carried. At the posterior end of this sac is an opening through which the young crawl soon after hatching from the egg. The young are then quite lively, and scatter well over the stem and underside of the leaves of the plant.

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* A much more complete account of this insect with technical descriptions of all the described species in the genus Orthezia was published in the Thirty-second Annual Report of the Massachusetts Agricultural College, 1895, pp. 111-133. The Plate illustrating this article is taken from that source.

As they grow older they become sluggish, but always retain their power of locomotion. The mature males have a single pair of wings, and, being very minute and also rare, are seldom noticed.

Fig. 1 on Plate I. shows the female from above, and Fig. 2, the same insect from beneath. Fig. 6 is of a half-grown insect. These figures are magnified twenty diameters. The other figures show structural details.

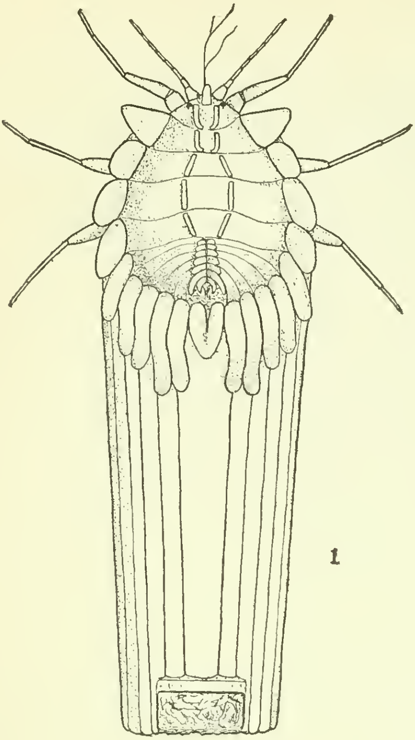
The Greenhouse Orthezia has not as wide a range of food plants as the Mealy Bug, but it attacks a greater variety of plants than most florists are aware of. It has been found on lantana, verbena, lemon verbena, coleus, salvia, libonia, peristrophe, ipomœa, ageratum, cineraria, eupatorium, stevia, chrysanthemum, pilea, segar plant, oxalis, pelargonium, abutilon, malvaviscus, fuchsia, heliotrope, periwinkle, potato, mint, white violet, and forget-me-not. In tropical countries it is reported as infesting citrus plants. On all in the list as far as chrysanthemum, when allowed to increase without molestation in the Insectary greenhouse, it became sufficiently injurious to cause the death of the plant.

Coleus appears to be the most favorable plant for its increase, and it is of its injuries to this plant, especially to the variety known as *verschaffeltii*, that florists most frequently complain. During the winter it is very destructive to the coleus cuttings in the greenhouses, and, if at all numerous on the young plants when they are set out in spring, it is almost sure to increase in a short time to such prodigious numbers that it kills or greatly weakens the plants before frost in the fall.

REMEDIES.

As the plants which this pest infests are mostly tender annuals, it is difficult to destroy the insects with insecticides without injuring the plants. This makes preventive measures of more importance to hold the insects in check than remedial ones. Most of the plants are used for bedding purposes, and as these are nearly all placed out of doors in the summer, not many insects would get into the houses to breed and cause trouble in the winter if the plants brought in from outside and the few which may have been kept in the houses during the summer were thoroughly cleaned in the fall. Cuttings for stock should only be made from uninfested plants, and cuttings or plants received from other dealers should be examined at once and rejected

PLATE I.



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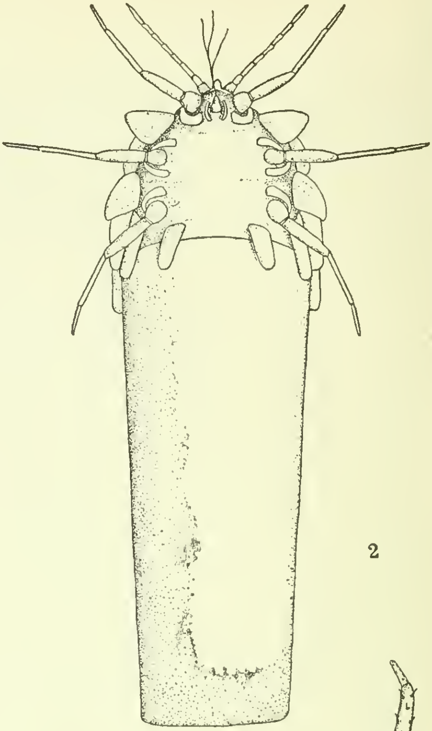

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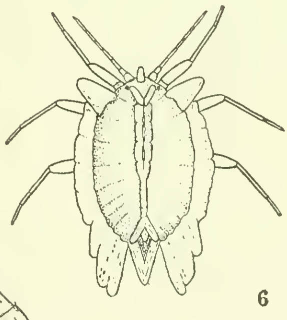

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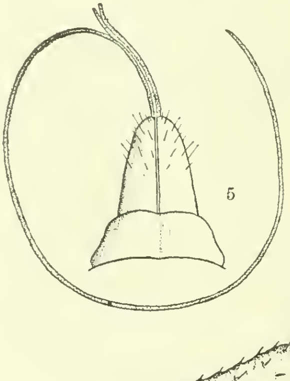

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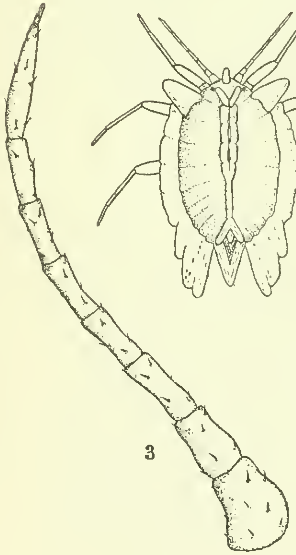

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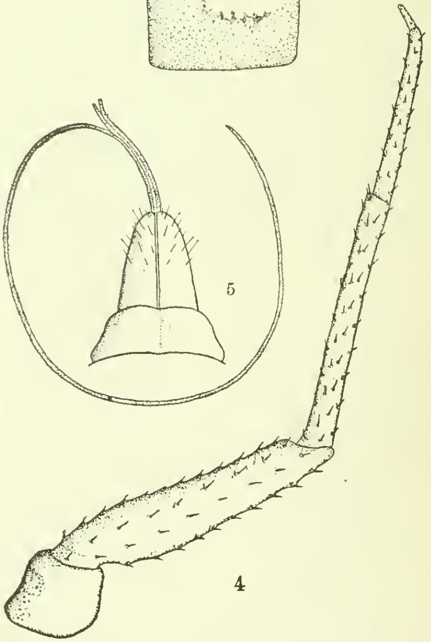

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C. P. Lounsbury.

PLATE I.

ORTHEZIA INSIGNIS DOUG., FEMALE.

Fig. 1. Adult female; dorsal view, enlarged 20 diameters.
2. Adult female; ventral view, enlarged 20 diameters.
3. Adult female; antenna.
4. Adult female; fore leg.
5. Adult female; rostrum, from the front; two of the bristles are shown cut off near the base, while the third is fully extended.
6. Nymph, after the second molt.

All the figures were drawn from specimens newly mounted in glycerine; the outlines were obtained by aid of the camera lucida.

or at least thoroughly cleaned if found infested ; this last point is an important one, as the insect has undoubtedly been introduced into new districts through the agency of auction houses, and has often become extremely abundant before being recognized as a new enemy.

These precautionary measures should be supplemented by frequent syringing with as severe a spray of water as the plants will stand if any insects make their appearance. Many plants like coleus, however, will not stand a syringing severe enough to wash off all the insects, and so resort to an insecticide is often found necessary.

Of the florists who use an insecticide against this insect, nearly all use fir-tree oil, and all who do speak very highly of its effectiveness. This substance has been tried at the Insectary, and when used in the proportions recommended by its manufacturers for the Mealy Bug, it has been found to be very efficient in destroying the Greenhouse Orthezia. Its costliness is the greatest objection to its use.

Kerosene emulsion is another good insecticide, and one that is not as commonly used by florists as it deserves to be. Doubtless this is because it is a little troublesome to prepare, but those who are willing to take this trouble are well repaid. The emulsion which was found to be the most efficient on the Greenhouse Orthezia in experiments conducted at the Insectary was Cook's emulsion. This is made by adding one pint of kerosene to a boiling solution of one-quarter pound of hard soap in two quarts of water. and churning the mixture thus formed until it is thoroughly emulsified, which takes about five minutes ; for use, the emulsion is diluted with twice its bulk of water. It must not be expected that every insect will be destroyed by one application of either fir-tree oil or kerosene emulsion, and besides, the eggs in the ovi-sac are not always reached. Dipping the plants in the substance and holding them submerged for a few seconds appears to be a more successful method than spraying them.

The insects remaining on the plants left out of doors are killed by the first severe frost, so no danger need be apprehended from them.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS
AGRICULTURAL COLLEGE.

BULLETIN No. 29.

FUNGICIDES,
INSECTICIDES,
SPRAYING CALENDAR.

MAY, 1895.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1895.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

AMHERST, MASS.

At the organization of the Experiment Station of the Massachusetts Agricultural College under the provisions of the Hatch Bill, it was decided to name it the "Hatch Experiment Station of the Massachusetts Agricultural College," in order to distinguish it from the State Agricultural Experiment Station, already located on the college grounds, but having no connection with it.

Its officers are :—

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Charles H. Fernald, Ph. D.,	*Entomologist.*
	Meteorologist.
William M. Shepardson, B. Sc.,	*Assistant Horticulturist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Charles P. Lounsbury, B. Sc.	*Assistant Entomologist.*

The coöperation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station,

Amherst, Mass.

Division of Horticulture.

S. T. Maynard.

DIRECTIONS FOR THE USE OF FUNGICIDES AND INSECTICIDES THE SEASON OF 1895.

During the season of 1894, farm and garden crops were more largely exempt from serious injury by insect and fungous pests than usual, owing to various causes, but largely because of the extremely dry weather.

The beneficial results of the use of fungicides and insecticides for the past three or four years, however, make it certain that we cannot afford to run the risk of being unprepared, but should always use the best known remedies for insect and fungous pests as a matter of regular routine, in the same way as we fertilize or cultivate our crops.

The work of the Horticultural Division of the Hatch Experiment Station during the past season has been along the same lines as in former years. In some cases, notwithstanding the scarcity of subjects for treatment, positive results were obtained by the use of fungicides and insecticides.

The season for the treatment of our fruit crops to prevent injury from insects and fungous growths is fast approaching, and we give below directions for this work based upon the results of our own experiments, those obtained by other stations and from the results of individual practical growers.

COMBINED INSECTICIDES AND FUNGICIDES.

While the work of this division is largely confined to the study and treatment of fungous diseases, we have combined insecticides and fungicides, because such combination can be applied more economically.

FUNGICIDES.

Nothing has been discovered during the past year that is more effective or better adapted to general use as a fungicide than the Bordeaux mixture and the Ammoniacal Carbonate of Copper.

Bordeaux Mixture,

Formula. 4 lbs. Copper Sulphate, (*Blue Vitriol*)
4 lbs. Caustic Lime (Unslaked Lime).

Dissolve the Copper in hot water. (If suspended in a basket or sack in a tub of cold water it will however dissolve in from two to three hours.)

The Lime is then slaked in another vessel adding water slowly that it may be thoroughly slaked. When both are cool, pour together, straining the lime through a fine mesh sieve or burlap strainer, and thoroughly mix. Before using, add water enough to make

(A) 25 gallons of the mixture or
(B) 50 " " " "

The active agent in this mixture is the copper, the lime being used simply to hold it in place upon the foliage and branches of the plants sprayed. Here it is given up gradually, destroying the spores of the fungi as they are brought in contact with it by the surrounding atmosphere.

Should the lime be air slaked, more than four pounds may be needed as it will have lost much of its strength. To test this, dissolve a little ferrocyanide of potassium (yellow prussiate of potash) in a small bottle and after the Bordeaux mixture has been prepared pour a few drops of the ferrocyanide solution into it. If a brown precipitate is made,add more lime until no reaction takes place,when the mixture is neutral or alkaline and will not injure the foliage of delicate trees like the peach and cherry.

Ammoniacal Carbonate of Copper.

Formula. 3 oz. Carbonate of Copper.
Liquid ammonia enough to dissolve the Copper, which will be about 3 qts., varying somewhat according to its strength.

Before using, dilute with water to 25 gallons.

This mixture is to be used after the fruit approaches ripening, when it would be disfigured by the Bordeaux mixture.

INSECTICIDES.

For general purposes two insecticides only are used. Paris green for all chewing insects and Kerosene emulsion for sucking insects.

Paris Green. This is too common a substance to need description and is used in preference to London Purple because it is more uniform in composition and results than the latter.

Kerosene Emulsion.

Formula. $\frac{1}{2}$ lb. common bar soap,
2 gallons common kerosene.

Cut the soap into small pieces or shavings and dissolve in about two gallons of hot water. While still hot,pour in the kerosene and with the hand pump or syringe, pump it back and forth until a thick butter-like substance is formed. In this condition the kerosene is divided into very minute globules and will be readily diluted or suspended in water.

Before using, add water enough to make

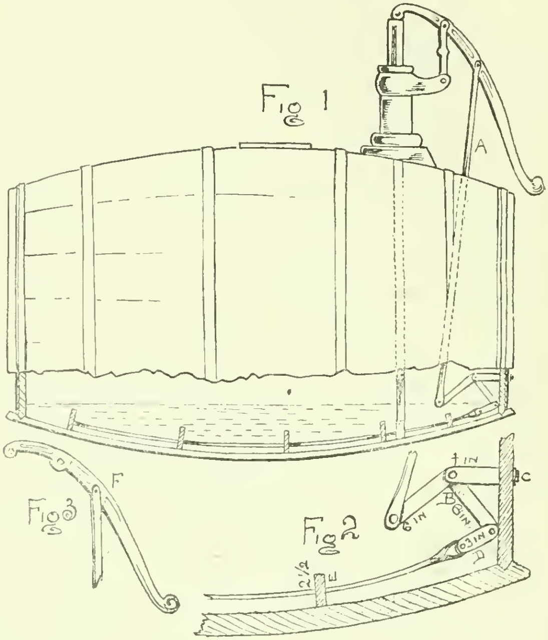
(A) 10 gallons of Emulsion
(B) 20 " " "

EQUIPMENT FOR SPRAYING.

Pumps. To obtain the best results, both insecticides and fungicides should be put on in as fine a spray as possible. When any liquid is applied in a stream, much of it runs off and is wasted, while if put on in a fine mist it adheres in minute drops which, when dry are held firmly by the hairs and uneven surfaces of the leaves.

In different sections of the country,pumps are being manufactured especially adapted for the application of fungicides and insecticides and many of them have reached a good degree of perfection. Without advertising any one of them as superior to others, we would advise purchasing from reliable manufacturers and those made as near home as possible. This last is very important that in case of breakage or injury, parts of the pump may be obtained in as short time as possible.

Nozzles. Of the nozzles in use the various forms of the Vermorel are perhaps the best for the fine mist spray. The Gem, (adjustable) Stott, McGowan and Deeming also are very satisfactory.



It must be borne in mind in the use of any pump, no matter how well constructed, that it is liable to get out of order and the manipulator should fully understand the construction of every part and be able to put boxes and packing in repair when out of order. After using, clear water should always be run through the pump before it is put away.

AN AUTOMATIC AGITATOR.

One of the greatest obstacles to the successful use of fungicides and insecticides has been that of keeping the solid particles of the mixture in suspension so that a uniform quantity can be put on all parts of the trees or plants sprayed. To overcome this difficulty many appliances have been made to agitate the liquids so that these particles should not settle, but most of them have been failures.

The accompanying figure illustrates an agitator which has been found effective and easy of construction by any one accustomed to the use of ordinary tools and which is given to the public in the hope that it will make the results of spraying with the Bordeaux mixture and Paris green more uniform, safe and satisfactory.

This contrivance, shown at Fig. 1, is made for use with the barrel lying on its side, which we consider the best way to carry it, and consists of an arm (*A*) of flat iron one-eighth inch thick and seven-eighths inch wide, attached to the handle of the pump and entering the barrel about six or eight inches from its head. This arm is attached to an elbow (*B*), with arms six inches in length, which is fastened into a socket about four inches in length, that is bolted to the head of the barrel at (*C*). At the lower end of the elbow is attached a short arm (*D*), which is joined to the long arm that carries the dashers or agitators (*E*). This joint is necessary in order that the dashers may lie on the bottom of the barrel, and not be lifted up at every stroke of the pump. With the movement of the pump handle, the dashers move backward and forward over the entire bottom of the barrel, thus keeping the liquid in constant motion. In order that the liquid that may have settled on the bottom may be stirred thoroughly before starting the pump, the arm (*A*) is fitted to the pump handle by a slot (*F*), so that it may be quickly slipped off and worked upward and downward a few times before beginning to pump. All the parts are made of flat iron one-eighth inch thick by three-fourths inch wide, and can be made by one having facilities for cutting such iron and drilling holes to fasten it together. The parts are held together by short stove bolts. The dashers are fastened to the rod by a screw passing through it.

In the adjustment of this apparatus to the barrel, the pump must be brought near enough to the end of the barrel to allow of the full sweep of the pump handle, and the rod, (*A*) fixed to the handle so as to give a full sweep to the elbow (*B*) that the dashers may be carried forward and backward to their fullest extent. We have tested this agitator as far as it is possible at this season of the year, and feel that, if properly adjusted, it will be entirely satisfactory. No patent has been applied for on this appliance, though it originated with us, and we wish the fruit growers of the country to have the benefit of it.

SPRAYING CALENDAR FOR 1895.

APPLE.

1st* Spraying. Bordeaux mixture (A) just before leaves unfold.

2d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 100 gallons, just before the blossoms open.

3d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 100 gallons, as soon as the petals have all fallen.

4th spraying. Bordeaux mixture (B) in from ten days to two weeks from last spraying.

5th spraying. Bordeaux mixture (B) in from two to four weeks according to the weather. If dry and cool, the longer period, but if moist and warm, the shorter time.

6th spraying. Ammoniacal Carbonate of Copper as the fruit approaches maturity if the weather should be warm and moist.

This treatment is for the destruction of the *codling moth*, *tent caterpillar*, *canker worm*, *apple* and *plum curculio*, the *apple scab* or *fusicladium* and the *leaf blight* or *cedar apple* fungus.

Under ordinary conditions the first four applications will be sufficient and where the canker worms and tent caterpillars are not abundant the second spraying may possibly be omitted.

PEAR.

The 1st, 2d and 3d sprayings should be the same as for the apple.

4th spraying. Bordeaux mixture (B) in one to two weeks.

5th spraying. Ammoniacal Carbonate of Copper when the fruit is nearly grown.

This treatment is for the *codling moth*, the *pear scab* and *leaf* and *fire blight.*

For the *pear tree psylla* use for 1st spraying, Kerosene Emulsion (A) as soon as the first insect is detected.

2d spraying. Kerosene Emulsion (A) in from one to two weeks if the young insects begin to appear.

3d spraying. Kerosene Emulsion (B) in from one to two weeks.

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*In the first application before the leaves unfold it is believed that the Bordeaux mixture will give better results than the simple solution of copper sulphate recommended in Bulletin No. 25.

PEACH.

1st spraying. Bordeaux mixture (A) just before the flower buds open.
2d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 150 gallons, as soon as the petals have fallen.
3d spraying. Bordeaux mixture (B) in from two to four weeks.
4th spraying. Ammoniacal Carbonate of Copper, diluted to 50 gallons, as the fruit approaches maturity.

This is for the *plum curculio*, the *leaf blight*, and the *brown fruit-rot*.

PLUM.

1st spraying. Bordeaux mixture (A) just before the flower buds begin to open.
2d spraying. Bordeaux mixture (A) and Paris green, 1 lb. to 100 gallons, as soon as the petals have fallen.
3d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 150 gallons, in from five to seven days.
4th spraying. Ammoniacal Carbonate of Copper, as the fruit approaches maturity.

The above treatment is for the *plum curculio*, the *black knot*, the *brown rot* and *leaf blight*.

CHERRY.

For the *plum curculio*, *black knot*, *leaf blight*, and *brown rot*, spray as for the peach.

For the *black aphis* use the kerosene emulsion (A), after the 3d application of the Bordeaux mixture, throwing it with as much force as is possible in, among and under the curled leaves where this insect is found sheltered.

GRAPE.

1st spraying. Bordeaux mixture (A) before the buds unfold.
2d spraying. Bordeaux mixture (A) and Paris green, 1 lb. to 100 gallons, just before the blossoms open.
3d spraying. Bordeaux mixture (A) and Paris green as soon as the grapes have set, i.e. in from five days to two weeks.

4th spraying. Bordeaux mixture (B) in from two to four weeks according to weather.

5th spraying. Ammoniacal Carbonate of Copper, when the fruit is near the first stages of coloring.

This is for the *rose-bug*, *mildew* and *black rot.*

RASPBERRY AND BLACKBERRY.

1st spraying. Bordeaux mixture (A) just before growth begins.

2d spraying. Bordeaux mixture (B) as the first blossoms open.

3d spraying. Bordeaux mixture (B) as soon as the fruit is gathered.

4th spraying. Bordeaux mixture (B) should the fall orange rust appear in from two to four weeks.

This treatment is for the *spring orange rust*, *fall orange rust*, *anthracnose* and *leaf blight.*

CURRANT.

1st spraying. Bordeaux mixture (A) just before the buds begin to open.

2d spraying. Bordeaux mixture (B) as soon as the fruit has set.

3d spraying. Bordeaux mixture (B) as soon as the fruit has been gathered.

This is for the *leaf blight.*

The *currant worms* are best destroyed by using hellebore or Pyrethrum in water, one tablespoonful to two gallons sprayed over the bushes, or by dusting them with the same while they are wet with rain or dew.

STRAWBERRY.

1st spraying. Bordeaux mixture (B) and 1 lb. of Paris green to 100 gallons, as soon as growth begins.

2d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 150 gallons, not later than the opening of the first flowers.

3d spraying. Bordeaux mixture(B)as soon as the fruit is gathered, if the bed is to be fruited a second season.

This is for the *black paria* and the *leaf blight.*

The *newly set fields* for next year's fruiting should be sprayed with the Bordeaux mixture two or three times at intervals of from two to four weeks after they begin to make runners.

POTATOES.

1st spraying. Bordeaux mixture (A) and Paris green, 1 lb. to 100 gallons as soon as the larvae of the potato beetle or the flea beetles appear.

2d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 150 gallons whenever the insects demand attention.

3d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 150 gallons should the insects appear in abundance.

For the *potato beetle*, the *flea beetle* and the *potato blight* and *rot* the above treatment has been found very effective.

CELERY.

1st spraying. Bordeaux mixture (A) when the plants are half grown in seed bed.

2d spraying. Bordeaux mixture (A) just before the plants are set in the field.

3d spraying. Bordeaux mixture (B) after plants get well established in the field.

4th spraying. Bordeaux mixture (B) should the blight conntinue.

This is for the *celery rust* and *leaf blight*.

BLACK POPLAR TREES.

1st spraying. Bordeaux mixture (B), about July 1st.

2d spraying. Bordeaux mixture (B) in from two to four weeks according to the weather.

This is for the *leaf rust*.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 30.

COMMERCIAL FERTILIZERS.

JUNE, 1895.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1895

DIVISION OF CHEMISTRY.

C. A. GOESSMANN.

I. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

1—5. WOOD ASHES.

I, II and III. Sent on from Concord, Mass.
IV. Sent on from West Springfield, Mass.
V. Sent on from Greenfield, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	9.81	7.25	8.67	1.46	.30
Calcium oxide,	24.73	34.86	36.38	37.24	34.54
Potassium oxide,	6.92	6.08	7.68	6.52	4.12
Phosphoric acid,	1.50	1.44	1.40	2.46	1.58
Insoluble matter,	10.86	11.71	10.87	7.13	27.34

6—10. WOOD ASHES.

I. Sent from Concord, Mass.
II. and III. Sent on from Boston, Mass.
IV. Sent on from South Chelmsford, Mass.
V. Sent on from Lawrence, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	13.67	10.50	15.96	12.50	10.30
Calcium oxide,	33.20	36.60	34.04	*	39.20
Potassium oxide,	5.84	6.24	5.88	4.88	6.60
Phosphoric acid,	1.28	1.80	1.54	1.10	1.16
Insoluble matter,	14.89	11.08	11.01	21.03	9.93

11—15. WOOD ASHES.

I. Sent on from Hadley, Mass.
II. Sent on from South Egremont, Mass.
III. Sent on from Concord, Mass.
IV. Sent on from Greenbush, Mass.
V. Sent on from Hingham, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	16.70	8.11	20.80	8.75	13.21
Calcium oxide,	30.40	37.00	22.00	38.40	35.60
Potassium oxide,	3.80	6.40	3.84	6.64	7.28
Phosphoric acid,	1.16	1 54	1.28	1.66	1.40
Insoluble matter,	21.29	11.94	27.43	11.34	11.69

16—20. WOOD ASHES.

I. Sent on from Hingham, Mass.
II and III. Sent on from Concord, Mass.
IV. Sent on from Montague, Mass.
V. Sent on from Sunderland, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100 C.,	6.60	11.80	9.08	4.62	4.30
Calcium oxide,	25.00	35.40	32.20	*	*
Potassium oxide,	4.56	6.48	5.40	4.62	4.60
Phosphoric acid,	1.02	1.28	1.40	1.92	2.02
Insoluble matter,	34.89	11.83	20.70	12.45	13.43

21—22. COTTON-SEED HULL ASHES.

I. Sent on from Hatfield, Mass.
II. Sent on from Sunderland, Mass.

	Per Cent.	
	I.	*II.*
Moisture ot 100° C.,	10.44	9.10
Calcium oxide,	7.48	*
Potassium oxide,	24.68	21.78
Phosphoric acid,	5.16	6.17
Insoluble matter,	20.30	*

23—26.

I. Cotton-seed meal sent on from Hatfield, Mass.
II. Cotton-seed meal sent on from Sunderland, Mass.
III. Cotton waste sent on from Seekonk, Mass.
IV. Southern tobacco stems sent on from Hatfield, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	6.79	7.05	6.78	10.55
Potassium oxide,	1.76	1.50	1.76	10.60
Phosphoric acid,	2.44	2.40	.54	.76
Nitrogen,	8.10	7.35	1.34	2.34
Insoluble matter,	.28	*	20.18	*

27—31.

I and II. Blood and bone, sent on from Concord, Mass.
III. Meat and bone sent on from Fairhaven, Mass.
IV. Tankage, sent on from Holyoke, Mass.
V. Tankage and blood, sent on from Assonet, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	8.67	8.05	4.82	11.95	14.43
Total phosphoric acid,	10.62	11.39	18.54	12.16	6.84
Available phosphoric acid,	2.82	*	5.74	6.02	6.52
Insoluble phosphoric acid,	7.80	*	12.80	6.14	.32
Nitrogen,	6.68	6.86	5.13	6.50	5.88

*Not determined.

I. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1895, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
4	Odorless Mineral Guano,	Forest City Wood Ash Co., Boston, Mass.,	Amherst.
9	Potato and Root Crop Fertilizer,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
16	Complete Corn and Grain Fertilizer,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
17	Superphosphate,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
19	Whitttemore's Complete Manure,	Whittemore Brothers, Wayland, Mass.,	Amherst.
23	Wood Ashes,	Forest City Wood Ash Co., Boston, Mass.,	N. Amherst.
33	Oats and Top-dressing Fertilizer,	Rogers and Hubbard Co., Middletown, Conn.,	Amherst.
43	Potato Manure,	Quinnipiac Fertilizer Co., Boston, Mass.,	Springfield.
50	Potato Manure,	Clark Cove Fertilizer Co., Boston, Mass.,	Springfield.
55	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Worcester.
58	Havana Tobacco Fertilizer,	Quinnipiac Fertilizer Co., Boston, Mass.,	Springfield.
60	Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Worcester.
67	Essex Complete Potato and Root Manure,	Russia Cement Co., Gloucester, Mass.,	Amherst.
72	Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
73	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
79	High Grade Special for Potatoes, Onions and Tobacco.	Williams & Clark Fertilizer Co., Boston, Mass.,	Springfield.
81	Potato and Vegetable Manure,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
86	Potato Fertilizer,	Williams & Clark Fertilizer Co., Boston, Mass.,	Springfield.
93	Tobacco Fertilizer,	Clark Cove Fertilizer Co., Boston, Mass.,	Springfield.
97	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Springfield.
98	Potato Manure,	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Worcester.
103	Crossed Fish and Potash,	Quinnipiac Fertilizer Co.,	Springfield.
105	Animal Fertilizer,	N. Roy & Son, So. Attleboro, Mass.,	Amherst.
107	Potato, Onion and Tobacco Manure,	Leander Wilcox, Mystic, Conn.,	Amherst.
110	High Grade Fish Guano and Potash,	E. Frank Coe, New York City, N. Y.,	Westfield.
111	Potato Special,	Walker Stratman & Co., Pittsburg, Pa.,	Amherst.
127	Potato Special,	Walker Stratman & Co., Pittsburg, Pa.,	Worcester.
135	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
147	Potato Manure,	Quinnipiac Fertilizer Co., Boston, Mass.,	Worcester.
158	Essex Complete Potato and Root Manure,	Russia Cement Co., Gloucester, Mass.,	Palmer.
256	Wood Ashes,	Forest City Wood Ash Co., Boston, Mass.,	Boston.
259	Potato and Vegetable Manure,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
284	High Grade Special for Potatoes, Onions and Tobacco.	Williams & Clark Fertilizer Co., Boston, Mass.,	Sunderland.
287	Potato Manure,	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Hingham.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
4	Odorless Mineral Guano,	2.95	—	—	—	.52	19.82	20.34	20.34	.52	—	.50	.50
9	Potato and Root Crop Fertilizer,	9.27	4.13	4.12-4.94	4.76	2.34	1.76	8.86	6-8	7.10	5-6	8.24	7-9
16	Complete Corn and Grain Fertilizer,	3.45	3.17	3.71-4.12	4.78	2.92	4.70	12.40	8-10	7.70	6-8	6.60	6-8
17	Superphosphate,	6.43	1.81	1.69-2.47	9.82	.48	4.48	14.78	10-12	10.30	8-10	3.16	2.5-3
19	Whittemore's Complete Manure	12.01	2.84	2.47-3.30	6.68	4.28	.90	11.86	12-14	10.96	8-12	4.73	3-4
23-256	Wood Ashes,	16.27	—	—	—	—	—	1.71	1.5-2.5	—	—	5.35	4.5-8
33	Oats and Top-dressing Fertilizer,	3.89	9.20	9.-9.50	.67	4.46	3.08	8.21	8-9	5.13	—	10.05	8.5-9.5
43-147	Potato Manure,	10.97	2.47	2.47-3.30	5.30	1.72	—	7.02	7-11	7.02	6-9	5.88	5-6*
50	Potato Manure,	11.31	2.56	2.47-3.30	3.56	3.70	2.44	9.70	7-11	7.26	6-9	5.20	5-6*
55-73	A. A. Ammoniated Superphosphate,	18.41	2.55	2.47-3.30	8.70	1.72	.43	10.85	—	10.42	10-12	3.41	2-3
58	Havana Tobacco Fertilizer,	10.76	6.41	5.77-6.59	1.64	1.08	.59	3.31	6-9	2.72	5.7	11.06	10-12
60-72	Potato Manure,	11.15	3.69	3.30.	4.68	1.51	.46	6.65	—	6.19	5.75	11.32	10.
67-158	Essex Complete Potato, Root Manure	7.48	4.13	3.71-4.53	5.81	2.98	.69	9.48	7-9	8.79	6-8	9.83	8.5-10*
79-284	High Grade Special for Potatoes, Onions and Tobacco,	10.55	3.27	3.7-4.12	3.71	3.48	1.56	8.75	8-11	7.19	7-9	8.31	7-8
81-259	Potato and Vegetable Manure,	13.03	3.34	3.25-4.25	6.86	1.39	1.13	9.38	8-10	8.25	6-8	7.23	7-8
86	Potato Fertilizer,	12.53	3.16	2.47-3.30	4.60	2.04	1.84	7.88	7-11	6.64	6-9	5.64	5-6*
93	Potato Fertilizer,	6.75	5.96	5.77-6.59	.82	4.00	.87	5.69	—	4.82	5-7	12.20	10-12
97-135	Potato Manure,	16.03	2.43	2.5-3.25	3.86	4.23	.97	9.06	8-11	8.09	6.8	6.38	5-6
98-287	Potato Manure,	8.93	3.59	3.71-4.12	5.05	2.69	2.00	9.74	8-10	7.74	8.	8.26	6-8*
103	Crossed Fish and Potash,	13.55	3.18	3.30-4.12	3.58	2.54	2.14	8.26	5-8	6.12	3-5	5.24	3-5*
105	Animal Fertilizer,	4.79	4.43	4.28.	.52	7.42	6.66	14.60	11-95	7.94	—	8.80	8.80
107	Potato, Onion and Tobacco Manure	14.67	3.12	3.30-4.30	4.66	3.24	1.14	9.04	8-11	7.90	7-9	7.76	6-7*
110	High Grade Fish Guano and Potash	10.22	2.96	3.30-4.10	4.55	3.67	2.26	10.48	7-10	8.22	6-9	2.75	2.75
111-127	Potato Special,	7.95	2.28	1.65-2.47	7.05	4.01	1.29	12.35	13-15	11.06	9-10	5.60	5-6*

*Sulphate of Potash, the source of Potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1895, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
117	Carteret Potato Manure,	Eastern Farm Supply Association, Montclair, N. J.,	Amherst.
119	Blood Meat and Bone,	Springfield Provision Co., Brightwood, Mass.,	Amherst.
122	Original Bay State Bone Superphosphate,	H. F. Tucker, Boston, Mass.,	Taunton.
139	Fish and Potash,	National Fertilizer Co., Bridgeport, Conn.,	W. Springfield.
145	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Worcester.
150	Potato and Tobacco Fertilizer,	Standard Fertilizer Co., Boston, Mass.,	Palmer.
156	Carteret Potato Manure,	Eastern Farm Supply Association, Montclair, N. J.,	W. Springfield.
186	Soluble Pacific Guano,	Pacific Guano Co., Boston. Mass.,	So. Amherst.
187	Sanderson's Formula "A,"	Lucian Sanderson, New Haven, Conn.,	So. Amherst.
189	Special Potato Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
192	Brightman's Superphosphate,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
199	Ground Bone and Potash,	Armour & Co., Chicago, Ill.,	Pittsfield.
200	High Grade Potato Manure,	M. E. Wheeler & Co., Rutland. Vt.,	Pittsfield.
204	Concentrated Phosphate,	Cumberland Bone Phosphate Co., Boston, Mass.,	W. Springfield.
215	Vegetable and Vine Fertilizer,	Read Fertilizer Co., Syracuse, N. Y.	W. Springfield.
222	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Greenfield.
226	Dry Ground Fish.	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
227	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Greenfield.
229	Canada Hard Wood Ashes,	Monroe, Lalor & Co., Oswego, N. Y.,	Greenfield.
243	Sheep Fertilizer,	John J. Peters & Co., Long Island City, N. Y.,	Boston.
247	Sheep Fertilizer,	John J. Peters, & Co., Long Island City, N. Y.,	Amherst.
248	Dissolved Bone Black,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
253	Sheep Fertilizer,	John J. Peters & Co., Long Island City, N. Y.,	Boston.
288	Complete Manure for Heavy Soils.	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Hingham.
289	Dissolved Bone Black,	Bradley Fertilizer Co., Boston, Mass.,	Hingham.
	Bones.		
75	Pure Fine Ground Bone,	Thompson & Edwards Fertilizer Co., Chicago, Ill.,	Worcester.
94	Fine Ground Bone,	J. G. Jefferds, Worcester, Mass.,	Worcester.
168	Fine Ground Bone,	J. G. Jefferds, Worcester, Mass.,	Worcester,
176	Steamed Bone,	Mc. Quade Bros., West Auburn, Mass.	Worcester.
196	Ground Bone,	E. H. Smith, Northboro, Mass.,	Amherst.
197	Steamed Bone,	Mc. Quade Bros., West Auburn. Mass.,	Amherst.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.		Mechanical Analysis.			
								Total.		Available.							
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Fine.	Med. Fine.	Med.	Coarse Med.
	Compound Fertilizers.																
117-156	Carteret Potato Manure,	13.51	2.29	2.5-3.30	3.12	5.17	1.54	9.83	7.5-10.5	8.29	6.5-8.5	7.92	6-7				
119	Blood, Meat and Bone,	9.50	7.67	7-8	—	—	1.92	5.50	9.5-10.5	3.58	—	—	—				
122	Original Bay State Bone Super'phate	11.25	2.08	1.65-2.47	7.50	1.34	2.48	11.32	11-16	8.84	9-12	2.43	3-4				
139	Fish and Potash,	5.71	2.54	3.5-4.5	1.28	4.00	4.46	9.74	6-8	5.28	—	4.98	4-5				
145	Potato and Root Crop Manure,	8.25	3.30	3-4	2.48	5.56	3.84	11.88	10-12	8.04	6-8	7.33	7-9				
150	Potato and Tobacco Fertilizer,	13.31	2.15	2.06-2.80	5.60	3.17	1.84	10.61	9-13	8.77	8-12	3.87	3.4*				
186	Soluble Pacific Guano,	14.09	2.20	2.25-3.00	7.42	1.68	1.86	10.96	10.5-16	9.10	8-12	3.16	2-3.5*				
187	Sanderson's Formula "A,"	9.00	3.18	3.30-4.12	6.76	.10	2.94	9.80	10-12	6.86	6-8	9.36	6-8				
189	Special Potato Fertilizer,	13.47	3.32	3.29-4.12	4.82	4.76	.94	10.52	9-13	9.58	8-11	8.32	7-9				
192	Brightman's Superphosphate,	12.39	2.92	2-47.3.30	3.38	2.22	2.40	8.00	8.11	5.60	6-8	6.36	5-6*				
199	Ground Bone and Potash,	4.00	2.40	1.85-2.68	2.62	2.33	8.70	13.65	8-12	4.95	—	2.99	2-3				
200	High Grade Potato Manure,	12.38	2.17	2.06-2.51	6.42	2.18	1.10	9.70	9-15	8.60	8-12	5.64	3.25-4.00*				
204	Concentrated Phosphate,	11.50	3.34	3.30-4.12	5.40	3.28	2.30	10.98	10-14	8.68	8-11	8.40	7-8				
215	Vegetable and Vine Fertilizer,	10.56	1.86	1.6-2.47	3.76	2.42	1.76	7.94	7-9	6.18	6-8	9.16	8-10*				
222-227	Am. Wheat & Corn Phosphate,	12.80	2.16	2-3	7.36	3.36	1.56	12.28	11-14	10.72	10-12	1.64	1.6-2.7				
226	Dry Ground Fish,	10.80	7.00	7.41-9.06	—	—	3.90	8.25	7-9	4.35	—	—	—				
229	Canada Hard Wood Ashes,	14.63	—	—	—	—	—	1.68	—	—	—	6.04	—				
243,247-253	Sheep Fertilizer,	15.63	2.36	1.65	—	—	—	1.62	1.20	—	—	2.16	1.70				
248-289	Dissolved Bone Black,	14.24	—	—	11.92	2.90	.58	15.40	15-18	14.82	—	—	—				
288	Complete Manure for Heavy Soils,	9.03	4.33	4.94-5.77	5.48	3.30	3.28	12.06	10-12	8.78	8-10	4.16	3-4*				
	Bones.																
75	Pure Fine Ground Bone,	7.96	2.19	2.47-3.30	—	—	6.09	24.37	22-26	18.28	—			66.74	18.80	9.63	4.83
94-168	Fine Ground Bone,	8.99	1.70	2.47-4.12	.64	19.50	8.16	28.30	25-30	20.14	—			89.22	9.14	1.64	—
176-197	Steamed Bone,	2.80	2.94	2.78	—	—	16.50	23.35	24.52	6.85	—			42.48	30.95	20.67	5.90
196	Ground Bone,	4.65	4.55	4.02	—	—	15.10	20.72	23.00	5.62	7.69			43.80	31.08	25.12	—

*Sulphate of Potash, the source of Potash.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1895. *Cents per pound.*
Nitrogen in ammonia salts,	18.5
" " nitrates,	15.
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	16.5
" " " cotton-seed meal,	12
" " " fine ground bone and tankage,	16
" " " fine ground medium bone and tankage,	14
" " " medium bone and tankage,	11
" " " coarse bone and tankage,	5
" " " hair, horn-shavings and coarse fish scraps,	5
Phosphoric acid soluble in water,	6
" " soluble in ammonium citrate,	5½
" " in fine bone and tankage,	5½
" " in fine medium bone and tankage,	4½
" " in medium bone and tankage,	3
" " in coarse bone and tankage,	2
" " in fine ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	5
" " insoluble (in am. cit.) in mixed fertilizers,	2
Potash as High Grade Sulphate, and in mixtures free from Muriate,	5¼
" " Muriate,	4½

The manurial constituents contained in feedstuffs are valued as follows:

Organic Nitrogen,	12
Phosphoric acid,	5
Potash,	5

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 31.

COMMERCIAL FERTILIZERS.

JULY, 1895.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1895.

DIVISION OF CHEMISTRY.

C. A. GOESSMANN.

I. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

32—35.

I. and II. Wool waste, sent on from North Andover, Mass.

III. Cotton dirt, sent on from Concord, Mass.

	Per Cent.		
	I.	*II.*	*III.*
Moisture at 100° C.,	6.41	6.34	5.97
Phosphoric Acid,	.30	—	.30
Potassium oxide,	4.64	.68	1.76
Nitrogen,	1.14	5.12	1.16

36—40.

I. II. and III. Animal meal, sent on from Ashfield, Mass.

IV. Meat scrap, sent on from Amherst, Mass.

V. Meat scrap, sent on from Ashfield, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	9.67	5.17	5.80	39.95	9.64
Phosphoric acid,	10.93	15.22	11.05	5.64	5.94
Nitrogen,	5.04	5.32	5.92	4.60	8.06

41—44.

I. and II. Tankage, sent on from Worcester, Mass.

III. Tankage sent on from Boston, Mass.

IV. Fine ground bone, sent on from Fairhaven, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	5.30	14.25	6.80	3.82
Total phosphoric acid,	10.90	14 01	15.86	30.20
Available phosphoric acid,	2.11	*	*	9.10
Insoluble phosphoric acid,	8.79	*	*	21.10
Nitrogen,	4.29	5.13	5.15	2.00

45—49.

I. and II. Fish waste, sent on from Boston, Mass.

III. Fish waste, sent on from Amherst, Mass.

IV. Ground bone, sent on from Rochester, Mass.

V. Blood and bone, sent on from Concord, Mass.

	Per Cent. *I.*	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	7.61	14.74	10.15	2.63	8.05
Total phosphoric acid,	6.28	11.96	6.42	29.30	11.39
Available phosphoric acid,	*	*	*	7.80	*
Insoluble phosphoric acid,	*	*	*	21.50	*
Nitrogen,	8.20	10.54	11.00	1.97	6.80

50—52. NITRATE OF SODA.

I. Sent on from Westford, Mass.
II. Sent on from Boston, Mass.
III. Sent on from Lunenburgh, Mass.

	Per Cent. *I.*	*II.*	*III.*
Moisture at 100° C.,	1.50	1.55	1.41
Nitrogen,	16.22	15.42	15.88

53—55.

I. Sulphate of potash, sent on from Townsend, Mass.
II. Muriate of potash, sent on from Westford, Mass.
III. Muriate of potash, sent on from Barre, Mass.

	Per Cent. *I.*	*II.*	*III.*
Moisture at 100° C.,	2.26	.75	.45
Potassium oxide,	50.35	49.90	51.60

56—57.

I. Muck, sent on from Harris, Mass.
II. Dry peat, sent on from Amherst Mass.

	Per Cent. *I.*	*II.*
Moisture at 100° C.,	7.92	18.61
Nitrogen,	.90	2.01

58—59.

I. Brewery refuse, sent on from Lowell, Mass.
II. Oil meal, sent on from Ashfield, Mass.

	Per Cent. *I.*	*II.*
Moisture at 100° C.,	9.94	10.49
Phosphoric acid,	.61	1.87
Potassium oxide,	1.15	1.23
Nitrogen,	1.18	5.54

*Not determined.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1895, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY No.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT
	Compound Fertilizers.		
1	Special Small Grain Guano,	Powers, Gibbs & Co., Wilmington, N. C.,	Amherst.
5	All Soluble,	Armour & Co., Chicago, Ill.,	Amherst.
10	Dissolved Bone Black,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
14	Complete Fertilizer for Top Dressing,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
26	Soluble Potato Manure,	Rogers & Hubbard Co., Middletown, Conn.,	Amherst.
31	Grass and Grain Fertilizer,	Rogers & Hubbard Co., Middletown, Conn.,	Amherst.
35	Quinnipiac Phosphate,	Quinnipiac Co., Boston, Mass.,	Springfield.
52	Great Planet "A" Manure,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
57	King Philip Alkaline Guano,	Clark's Cove Fertilizer Co.,Boston,Mass.,	Springfield.
63	Odorless Chemical Compound Vegetable Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Amherst.
68	Essex Perfected Lawn Dressing,	Russia Cement Co., Gloucester, Mass.,	Amherst.
69	Essex Complete Manure for Corn and Grain,	Russia Cement Co., Gloucester, Mass.,	Amherst.
76	Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
82	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
90	Grass and Grain Spring Top Dressing,	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Worcester.
96	Ground Tobacco Stems,	F. C. Sturtevant, Hartford, Conn.,	Worcester.
108	High Grade Fish and Potash,	Leander Wilcox, Mystic, Conn.,	Amherst.
114	Smoky City,	Walker Stratman & Co., Pittsburg, Pa.,	Amherst.
115	Carteret Market Garden Manure,	Eastern Farm Supply Association, Montclair, N. J.,	Amherst.
116	Carteret Farm Manure,	Eastern Farm Supply Association, Montclair, N. J.,	Amherst.
123	Potato Fertilizer,	Cumberland Bone Phosphate Co., Boston, Mass.,	Westfield.
125	Smoky City,	Walker Stratman & Co., Pittsburg, Pa.,	Westfield.
132	Odorless Chemical Compound Vegetable Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Taunton.
146	Carteret Market Garden Manure,	Eastern Farm Supply Association, Montclair, N. J.	Springfield.
148	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Worcester.
151	Quinnipiac Phosphate,	Quinnipiac Co., Boston, Mass.,	Worcester.
152	Essex Perfected Lawn Dressing,	Russia Cement Co., Gloucester, Mass.	Palmer.
164	Cartaret Market Garden Manure,	Eastern Farm Supply Association, Montclair, N. J.	S.Framingham
172	Essex Complete Manure for Corn and Grain,	Russia Cement Co., Gloucester, Mass.,	Palmer.
203	Essex Perfected Lawn Dressing,	Russia Cement Co., Gloucester, Mass.,	Pittsfield.
211	All Soluble,	Armour & Co., Chicago, Ill.,	Pittsfield.
236	Cartaret Farm Manure,	Eastern Farm Supply Association, Montclair, N. J.,	W.Springfield.
249	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
250	Ground Tobacco Stems,	F. C. Sturtevant, Hartford, Conn.,	Boston.
269	Essex Complete Manure for Corn and Grain,	Russia Cement Co., Gloucester, Mass.,	Lawrence.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
1	Special Small Grain Guano, ...	5.97	1.27	.82-1.24	6.68	.62	.98	8.28	—	7.30	8-10	2.48	2-3
5-211	All Soluble, ...	2.87	3.23	2.88-3.71	2.25	5.80	1.92	9.97	—	8.05	9-11	4.81	4-5
10	Dissolved Bone Black, ...	9.13	—	—	15.78	.94	.52	17.24	—	16.72	16	—	—
14	Complete Fert'zer for Top Dressing,	6.92	4.07	4.12.4.94	1.02	4.24	1.40	6.66	7-8	5.26	4-5	7.44	7-9
26	Soluble Potato Manure, ...	10.96	5.53	5-6	1.80	6.08	2.76	10.64	10-12	7.88	7-8	4.82	5-6*
31	Grass and Grain Fertilizer, ...	6.50	3.06	2.50-3.00	.16	6.64	8.24	15.04	16.5-18	6.80	—	13.64	12.5-13.50
35-151	Quinnipiac Phosphate, ...	13.94	2.74	2.47-3.30	6.65	3.00	2.77	12.42	10-14	9.66	9-12	2.86	2-3*
52	Great Planet "A" Manure, ...	11.62	3.42	3.30-4.12	5.38	4.96	—	10.34	9-10	10.34	8-10.5	7.30	7-8
57	King Philip Alkaline Guano, ...	13.73	1.76	1.03-1.65	5.73	3.23	1.02	9.98	9-12	8.96	8-10	2.66	2-3*
63-132	Odorless Chemical Comp. Veg. Fert.	3.15	3.36	3-4	.59	3.24	8.59	12.42	10.5-12.00	3.83	—	1.78	1-2
68-152-203	Essex Perfected Lawn Dressing, ...	10.59	4.22	4.12-4.94	3.94	3.22	2.28	9.44	7-9	7.16	6-8	7.22	7-9
69-172-269	Essex Com. Manure for Corn & Grain	8.90	4.50	4.5-5.5	3.84	4.72	2.18	10.74	8-10	8.56	7-9	9.20	9.5-11
76	Lawn and Garden Dressing, ...	9.25	4.40	3.25-4.25	5.38	1.92	4.60	11.90	8-10	7.30	6-8	5.88	5-6*
82-148-249	Hill and Drill Phosphate, ...	11.08	3.34	2.5-3.5	6.68	2.56	3.70	12.94	12-13	8.24	9-11	3.68	2-3
90	Grass & Grain Spring Top Dress'g	11.37	4.43	4.12-5.77	3.82	2.32	1.46	7.60	7-9	6.14	5-7	6.64	5-7
96-250	Ground Tobacco Stems, ...	11.41	2.40	1.96	—	—	—	1.15	.75	—	—	8.20	7.66
108	High Grade Fish and Potash, ...	20.05	3.75	3.25-4.25	2.72	3.20	1.30	7.22	6-8	5.92	5-7	4.44	4-5
114-125	Smoky City, ...	9.72	1.37	1.24-2.06	9.88	1.86	1.46	13.20	15-17	11.74	12-13	.80	1-1.5
115-146-164	Cartaret Market Garden Manure, ...	9.41	3.60	2.72-3.54	2.87	4.61	2.05	9.53	8-11	7.48	7-9	8.21	7-8
116-236	Cartaret Farm Manure, ...	16.10	2.48	2.06-2.72	3.92	5.42	1.56	10.90	11-14	9.34	10-12	3.68	2.5-3.5
123	Potato Fertilizer, ...	12.69	2.29	2-3	5.34	6.52	.12	11.98	11-13	11.86	9-11	2.92	3-4

*Sulphate of Potash, the source of Potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1895, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY No.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT
	Compound Fertilizers.		
126	Fertilizer for Garden and Lawns,	National Fertilizer Co., Bridgeport, Conn.,	Worcester.
129	Special Potato Fertilizer,	H. F. Tucker, Boston, Mass.,	Taunton.
130	Fish and Potash,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
134	Long Island Special	Eastern Farm Supply Association, Montclair, N. J.,	S.Framingham
153	Blood, Bone and Meat,	Lucian Sanderson, New Haven, Conn.,	W. Springfield.
154	Animal Fertilizer "G" Brand,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Worcester.
161	Grass Fertilizer,	Quinnipiac Co., Boston, Mass.,	Worcester,
163	Meat and Bone,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
170	Ammoniated Dissolved Bone,	Bowker Fertilizer Co., Boston, Mass.,	Worcester.
174	Long Island Special,	Eastern Farm Supply Association, Montclair, N. J.,	W.Springfield.
177	High Grade Potato Manure,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
181	"D" Fish and Potash,	Joseph Church & Co., Tiverton, R. I.,	Taunton.
182	Plymouth Rock Brand,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
185	Great Eastern General,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
188	Great Eastern Grain and Grass Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
194	Strawberry Manure.	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
206	Standard Unexcelled Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	Pittsfield.
208	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Pittsfield.
214	Standard Fish and Potash,	Standard Fertilizer Co., Boston, Mass.,	W.Springfield.
217	Canada Wood Ashes,	William E. Fyfe & Co., Clinton, Mass.,	Greenfield.
223	Sure Crop Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Gt. Barrington
232	Grass Manure,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
234	Fine Wrapper Tobacco Fertilizer,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
240	Standard Phosphate,	Read Fertilizer Co., Syracuse, N. Y.,	W.Springfield.
244	Breck's Lawn and Garden Dressing,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
246	Complete Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Boston.
251	Special Potato Manure,	Pacific Guano Co., Boston, Mass.,	Newburyport.
272	Ammoniated Dissolved Bone,	Bowker Fertilizer Co., Boston, Mass.,	Lawrence.
276	Lowell Bone Fertilizer,	Lowell Rendering Co., Lowell, Mass.,	Lawrence.
278	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Fitchburg.
281	Canada Wood Ashes,	William E. Fyfe & Co., Clinton, Mass.,	Amherst.
283	Gold Brand Excelsior,	E. Frank Coe, New York City, N. Y.,	Sunderland.
286	Complete Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Amherst.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	Guaranteed.
								Found.	Guaranteed.	Found.	Guaranteed.		
	Compound Fertilizers.												
126	Fertilizer for Garden and Lawns,	9.66	3.50	4-6	3.04	5.55	2.64	11.23	10-12	8.59	—	5.67	5-6
129	Special Potato Fertilizer,	9.75	2.13	2.06-2.88	6.27	1.66	1.60	9.53	9-12	7.93	8-11	5.28	6-7
130	Fish and Potash.	18.60	2.52	2.06-2.88	3.10	4.80	—	7.90	7.5-10.5	7.90	6-8	2.20	2-3
134-174	Long Island Special,	9.95	4.12	3.5-4.4	5.10	2.38	1.22	8.70	—	7.48	7.5-9.5	8.60	8-11
153	Blood, Meat and Bone,	3.89	6.21	5.77-7.41	.41	9.21	4.55	14.17	10-12	9.62	—	—	—
154	Animal Fertilizer, "G" Brand,	10.08	3.21	2.5-3.00	1.74	6.44	—	8.18	7-8	8.18	—	4.68	4
161	Grass Fertilizer,	8.02	4 81	3.91-4.74	1.51	3.73	.95	6.19	6-8	5.24	5-7	3.22	2-3
163	Meat and Bone,	5.91	2.22	4.24	.87	18.08	8.85	27.80	19-25	18.95	—	—	—
170-272	Ammoniated Dissolved Bone,	8.37	1.75	1.6-2.50	2.38	5.84	5.65	13.87	—	8.22	8-11	3.79	2.3
177	High Grade Potato Manure,	10.80	3.32	3.30-4.12	4.20	2.40	2.76	9.36	9-13	6.56	8-11	7.12	7-8
181	"D" Fish and Potash,	17.82	2.25	2.06-2.88	3.40	4.46	.56	8.42	7.5-10.5	7.86	6-8	2.56	2-3
182	Plymouth Rock Brand,	8.31	3.43	3.29-4.12	4.66	4.72	1.44	10.82	9-13	9.38	8-11	5.13	4-4.25
185	Great Eastern General,	14.73	1.18	.82-1.65	6.78	1.72	.82	9.32	9-15	8.50	8-12	4.60	4-6
188	Great Eastern Grain and Grass Fert.	12.69	3.03	2.88-3.71	6.66	1.10	1.50	9.26	—	7.76	8-12	2.24	2-4
194	Strawberry Manure,	10.89	2.93	2.5-3.25	4.50	2.77	.51	7.78	—	7.27	6-8	5.80	5-6
206	Standard Unexcelled Fertilizer,	14.45	2.36	1.85-2.26	4.76	4.36	1.02	10.14	—	9.12	8-10	2.92	2.25-3.00
208	Corn Fertilizer,	12 62	3.43	1.65-2.47	6.24	.96	1.50	8.70	9-13	7.20	8-11	3.00	2-3*
214	Standard Fish and Potash,	16.81	2.11	2.06-2.80	1.72	3.96	3.68	9.36	7-10	5.68	6-8	2.28	2-3
217-281	Canada Wood Ashes,	6.30	—	—	—	—	—	1.22	1-3	—	—	6.23	5-8
223	Sure Crop Phosphate,	11.87	1.00	.82-1.65	6.90	3.72	3.66	14.28	—	10.62	10-13	1.60	1-2
232	Grass Manure,	7.78	3.57	3.91-4.74	1.68	4.44	.08	6.20	—	6.12	5-7	3.44	2-3
234	Fine Wrapper Tobacco Fertilizer,	5.05	5.67	5.77-7.41	.90	2.02	2.48	5.40	6-8	2.92	5-7	12.12	10-13*
240	Standard Phosphate,	12.57	1.03	.82-1.65	5.58	1.82	1.76	9.16	10-12	7.40	8-10	4.36	4-6
244	Breck's Lawn and Garden Dressing,	5.30	5.80	4.12-4.94	1.76	3.74	1.84	7.34	—	5.50	5-6	5.48	5-6
246-286	Complete Animal Fertilizer,	3.95	4.82	3.30-4.12	2.04	4.86	5.50	12.40	14-17	6.90	—	7.48	7-8
251	Special Potato Manure,	12.45	2.84	2.47-3.30	5.22	1.14	1.18	7.54	—	6.36	5-7	5.24	5-6
276	Lowell Bone Fertilizer,	13.24	3.15	1. -2.5	4.88	.50	—	5.38	—	5.38	5-6	3.20	2-3
278	Ammoniated Bone Superphosphate,	8.22	3.40	3.5-4.5	6.60	3.70	1.62	11.92	—	10.30	10-12	1.64	2-3
283	Gold Brand Excelsior,	6.43	2.66	2.47-3.30	6.56	1.58	3.22	11.36	9-12	8.14	8-11	5.92	6-8*

*Sulphate of Potash, the source of Potash.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1895. *Cents per pound.*
Nitrogen in ammonia salts,	18.5
" " nitrates,	15.
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	16.5
" " " cotton-seed meal,	12
" " " fine ground bone and tankage,	16
" " " fine ground medium bone and tankage,	14
" " " medium bone and tankage,	11
" " " coarse bone and tankage,	5
" " " hair, horn-shavings and coarse fish scraps,	5
Phosphoric acid soluble in water,	6
" " soluble in ammonium citrate,	5½
" " in fine bone and tankage,	5½
" " in fine medium bone and tankage,	4½
" " in medium bone and tankage,	3
" " in coarse bone and tankage,	2
" " in fine ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	5
" " insoluble (in am. cit.) in mixed fertilizers,	2
Potash as High Grade Sulphate, and in mixtures free from Muriate,	5¼
" " Muriate,	4½

The manurial constituents contained in feedstuffs are valued as follows:

Organic Nitrogen,	12
Phosphoric acid,	5
Potash,	5

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN No. 32.

COMMERCIAL FERTILIZERS.

AUGUST, 1895.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE
1895.

DIVISION OF CHEMISTRY.

C. A. Goessmann.

I. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

60-64. WOOD ASHES.

I. Sent on from Harvard, Mass.
II. Sent on from Concord, Mass.
III. Sent on from Concord Junction, Mass.
IV. Sent on from Framingham, Mass.
V. Sent on from Fitchburg, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.18	15.45	6.72	17.44	12.97
Phosphoric acid,	.94	1.23	1.48	1.14	1.32
Potassium oxide,	2.92	8.05	6.06	6.00	5.19

65-69.

I. Sent on from Concord Junction, Mass.
II. Sent on from North Hadley, Mass.
III., IV. and V. Sent on from Concord, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	9.28	5.16	5.98	8.19	7.94
Phosphoric acid,	.96	1.28	1.68	1.29	1.34
Potassium oxide,	5.15	5.25	7.58	6.71	6.18

70-74.

I. and II. Sent on from Amherst, Mass.
III. Sent on from Sunderland, Mass.
IV. and V. Sent on from Hatfield, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	3.23	3.02	13.43	4.09	2.50
Phosphoric acid,	2.64	1.92	1.69	1.56	1.97
Potassium oxide,	8,36	6.54	5,68	5,99	4.53

75-79.

I. Sent on from South Sudbury, Mass.
II. Sent on from Concord, Mass.
III. and IV. Sent on from North Amherst, Mass.
V. Sent on from Harvard, Mass.

Per cent.

	I.	II.	III.	IV.	V.
Moisture at 100° C.,	6.50	13.69	14.12	13.12	8.75
Phosphoric acid,	1.40	1.75	1.61	2.75	1.18
Potassium oxide,	5.88	5.47	4.76	3.72	4.53
Insoluble matter,	—	—	14.12	19.39	17.50

80-84.

I. Sent on from Lawrence, Mass.
II. Sent on from Amherst, Mass.
III. Sent on from Mittineague, Mass
IV. Sent on from West Northfield, Mass.
V. Sent on from Billerica, Mass.

Per cent.

	I.	II.	III.	IV.	V.
Moisture at 100° C.,	14.98	6.72	11.14	6.91	7.76
Phosphoric acid,	1.33	1.48	1.25	1.30	1.36
Potassium oxide,	5.07	6.49	6.97	6.46	7.05
Insoluble matter,	11.69	10.45	10.36	6.46	7.53

85-88.

I. Sent on from Bolton, Mass.
II. Sent on from Hamilton, Mass.
III. Lime Ashes. Sent on from Concord, Mass.
IV. Texas Cotton Hull Ashes. Sent on from Sunderland, Mass.

Per cent.

	I.	II.	III.	IV.
Moisture at 100° C.,	4.56	8.59	20.61	7.42
Phosphoric acid,	1.38	1.25	—	6.29
Potassium oxide,	4.20	5.52	.60	23.70
Insoluble matter,	29.37	9.48	—	7.06

89-91. Refuse from the Cremation of Swill. Sent on from Northboro, Mass.

I. Fall Product.
II. Spring Product.
III. Summer Product.

Per cent.

	I.	II.	III.
Moisture at 100° C.,	1.20	1.19	.87
Phosphoric acid,	10.82	10.21	7.47
Potassium oxide,	5.71	4.83	4.08
Insoluble matter,	29.91	24.50	26.73

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1895, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY NO.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT.
	Compound Fertilizers.		
3	Sea Bird Ammoniated Guano,	Powers, Gibbs & Co., Wilmington, N. C.,	Amherst.
7	Bone and Blood,	Armour & Co., Chicago, Ill.,	Amherst.
12	Dry Fish Guano,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
15	Tankage,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
28	Fairchild's Formula for Corn and General Crops,	Rogers & Hubbard Co., Middletown, Conn.,	Amherst.
36	Universal Ammoniated Dissolved Bone,	Williams & Clark Fertilizer Co., Boston, Mass.,	Springfield.
37	Fish and Potash,	Clark's Cove Fertilizer Co.,Boston,Mass.,	Springfield.
42	Fish and Potash,	Quinnipiac Co., Boston, Mass.,	Springfield.
49	Odorless Chemical Compound Tobacco Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Springfield.
54	Universal Ammoniated Dissolved Bone,	Williams & Clark Fertilizer Co., Boston, Mass.,	Springfield.
56	Hampden Lawn Dressing,	B. L. Bragg & Co., Springfield, Mass.,	Springfield.
59	Bay State Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
62	Odorless Chemical Compound Tobacco Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Amherst.
77	Corn Manure	Quinnipiac Co., Boston, Mass.,	Springfield.
78	Fish and Potash "D" Brand,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
89	Dissolved Bone Black,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
92	X. L. Superphosphate,	Bradley Fertilizer Co., Boston, Mass.,	Springfield.
95	Complete Manure for General Use,	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Worcester.
102	Blood, Bone and Meat,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
109	Ammoniated Bone Superphosphate,	Leander Wilcox, Mystic, Conn.,	Amherst.
112	Big Bonanza Fertilizer	Walker Stratman & Co., Pittsburg, Pa.,	Amherst.
118	Carteret Corn and Grain Manure,	Eastern Farm Supply Association, Montclair, N. J.,	Amherst.
124	Cumberland Superphosphate,	Cumberland Bone Phosphate Co., Boston, Mass.,	Westfield.
131	Carteret Corn and Grain Manure,	Eastern Farm Supply Association, Montclair, N. J.	S.Framingham
136	Root Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	Springfield
137	Big Bonanza Fertilizer,	Walker Stratman & Co., Pittsburg, Pa.,	Westfield.
143	Standard Fertilizer,	Standard Fertilizer Co., Boston, Mass.,	Palmer.
144	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	Worcester.
155	Corn Manure,	Quinnipiac Co., Boston, Mass.,	Worcester.
166	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	W.Springfield.
183	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	Taunton.
205	Bone and Blood,	Armour & Co., Chicago, Ill.,	Pittsfield.
242	Standard Fertilizer,	Standard Fertilizer Co., Boston, Mass.	W.Springfield.
271	Cumberland Superphosphate,	Cumberland Bone Phosphate Co., Boston, Mass.,	Lowell.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	Guaranteed.
								Found.	Guaran- teed.	Found.	Guaran- teed.		
	Compound Fertilizers.												
3	Sea Bird Ammoniated Guano,	10.80	1.49	1.24-1.65	8.96	2.74	.38	12.08	—	11.70	8-10	3.38	2.50-3.00
7-205	Bone and Blood,	4.20	5.69	5.77-6.59	.38	10.64	2.28	13.30	10-12	11.02	5-7	—	—
12	Dry Fish Guano,	8.27	8.48	8.24.9.88	.30	4.74	2.84	7.88	7-9	5.04	—	—	—
15	Tankage,	3.20	6.57	6.59-7.41	—	6.14	6.78	12.92	8-9	6.14	—	—	—
28	Fairchild's Form., Corn & Gen. Crop	5.82	4.61	5.5-6.5	—	5.98	7.98	13.96	12-13	5.98	—	12.96	13-14
36-54	Univ. Ammoniated Dissolved Bone,	12.89	1.89	1.65-2.47	4.99	3.81	2.56	11.36	6-8	8.80	6-7	2.40	2-3
37	Fish and Potash,	17.16	2.46	2.00-2.50	3.08	9.06	1.94	14.08	7-11	12.14	6-8	3.13	2-3*
42	Fish and Potash,	12.21	2.09	2.06-2.88	5.40	3.47	1.36	10.23	6-9	8.87	4-6	4.25	4-6
49-62	Odorless Chem. Com. Tobacco Fert.	3.77	3.02	3.95-6.01	.59	1.34	8.42	10.35	8.6-11	1.93	5-7	1.65	2-4
56	Hampden Lawn Dressing,	8.11	2.84	3.30-4.12	1.61	3.54	1.02	6.26	7-9	5.15	5-6	3.75	2-3
59	Bay State Fertilizer,	13.07	2.74	2.47-3.30	6.16	3.76	2.14	12.06	10-12	9.92	9-11	2.53	2-3
77-155	Corn Manure,	12.22	2.31	2.06-2.88	5.28	3.74	2.10	11.12	10-14	9.02	9-12	2.43	1.50-2.50*
78	Fish and Potash "D" Brand,	8.50	2.75	2.47-3.30	1.84	3.02	5.28	10.14	8-10	4.86	—	2.80	2-3
89	Dissolved Bone Black,	11.62	—	—	12.92	3.58	1.80	18.30	16-18	16.50	16-18	—	—
92	X. L. Superphosphate,	3.10	2.57	2.47-3.30	7.12	3.12	1.38	11.62	11-14	10.24	10-13	2.14	2-3*
95	Complete Manure for General Use.	9.07	3.38	3.30-4.12	4.91	4.70	.74	10.35	10-12	9.61	8-10	5.81	4-5
102	Blood, Bone and Meat,	5.33	7.34	6.59-8.24	—	4.56	5.78	10.34	10-12	4.56	—	—	—
109	Ammoniated Bone Superphosphate,	16.75	3.29	2.50-3.50	3.96	3.06	.92	7.94	7-9	7.02	6-8	5.97	5-6*
112-137	Big Bonanza Fertilizer,	10.19	1.92	1.65-2.47	4.34	3.90	2.04	10.28	15-17	8.24	11-12	3.18	2-3*
118-131	Carteret Corn and Grain Manure,	11.55	3.41	3.30-4.12	5.34	3.92	.98	10.24	10-13	9.26	9-11	6.71	5.50-6.50
124-271	Cumberland Superphosphate,	11.83	2.29	2.00-3.00	7.20	2.16	1.38	10.74	10-12	9.36	8-10	2.80	2.00-3.00*
136	Root Fertilizer,	10.20	3.31	3.70-4.70	3.84	5.42	.77	10.03	10-12	9.26	8-10	6.49	6.00-8.00
143-242	Standard Fertilizer,	13.82	2.42	2.00-3.00	7.22	2.18	1.04	10.44	10-13	9.40	8-12	3.24	2-3
144-166-183	Market Garden Manure,	11.42	3.49	3.30-4.12	4.60	3.64	2.30	10.54	9-13	8.24	8-11	7.64	7-8

*Sulphate of Potash, the source of Potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1895, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
149	Essex Special Vegetable Manure,	Russia Cement Co., Gloucester, Mass.,	Palmer.
167	Dissolved Bone Black,	Lucian Sanderson, New Haven, Conn.,	W. Springfield.
173	Special Potato Fertilizer,	E. Frank Coe & Co., New York, N. Y.,	Westfield.
175	Animal Fertilizer,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
184	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
190	Fish and Potash,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
212	Ammoniated Dissolved Bone,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
218	Americus Corn Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
219	Fish and Potash,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
220	Eclipse Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	W. Springfield.
224	High Grade Farmers' Friend,	Read Fertilizer Co., Syracuse, N. Y.,	W. Springfield.
225	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Gt. Barrington
239	Dry Fish Guano,	Bradley Fertilizer Co., Boston, Mass.,	Greenfield.
273	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Fitchburg.
	Bones.		
29	Pure Ground Raw Knuckle Bone Meal,	Rogers & Hubbard Co., Middletown, Conn.,	Amherst.
30	Pure Ground Raw Knuckle Bone Meal,	Rogers & Hubbard Co., Middletown, Conn.,	Amherst.
32	Strictly Pure Fine Bone,	Rogers & Hubbard Co., Middletown, Conn.,	Amherst.
41	Pure Bone Meal,	Quinnipiac Co., Boston, Mass.,	Springfield.
104	Ground Raw Bone,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
120	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
121	Pure Ground Bone,	Bryant, Brett & Simpson, New Bedford, Mass.,	New Bedford.
157	Fine Ground Bone,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
180	Pure Ground Bone,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
193	Fine Ground Bone,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
257	Pure Ground Bone,	T. L. Stetson, Randolph, Mass.,	Boston.
260	Fine Ground Bone,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Newburyport.
262	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Boston.
264	Fine Ground Bone,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
265	Pure Ground Bone,	Bryant, Brett & Simpson, New Bedford, Mass.,	Amherst.
267	Pure Bone Meal,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
280	Pure Ground Bone,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Fitchburg.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.	
								Found.	Guaran-teed.	Found.	Guaran-teed.				
	Compound Fertilizers.														
149	Essex Special Vegetable Manure, ..	6.41	4.95	4.12-4.94	2.10	5.14	.79	8.03	7-9	7.24	6 8	5.65		5.5-6.5	
167	Dissolved Bone Black, ...	15.27	—	—	15.84	.70	.10	16.64	16-18	16.54	16-18	—		—	
173	Special Potato Fertilizer, ...	10.43	1.78	1.65-2.47	8.16	2.48	1.36	12.00	11-13	10.64	9-11	3.69		3.50*	
175	Animal Fertilizer, ...	8.53	3.30	3.30-4.12	2.48	4.62	7.30	14.40	10-12	7.10	6-8	5.48		4-6	
184	Vegetable, Vine and Tobacco Fert.,	12.41	2.14	2·06-2.88	6.45	2.56	.28	9.29	9-14	9.01	8-11	6.97		6-8	
190	Fish and Potash, ...	16.83	2.20	2.06-2.88	3.30	3.53	1.46	8.29	7.5-10.5	6.83	6-8	2.72		2-3*	
212	Ammoniated Dissolved Bone, ...	12.21	2.11	1.65-2.47	3.25	6.96	2.30	12.51	10-13	10.21	9-12	2.03		2-3	
218	Americus Corn Phosphate, ...	12.66	2 06	2.06-2.88	2.82	6.98	3.38	13.18	10-14	9.80	9-12	2.16		1.5-2.5	
219	Fish and Potash, ...	16.00	1.97	2.06-2.88	4.09	3.61	1.38	9.08	6-9	7.70	4-6	4.81		4-6*	
220	Eclipse Phosphate, ...	11.31	2.27	1.00-2.00	5.40	3.26	3.36	12.02	10-14	8.66	8-11	2.75		1.5-2.5	
224	High Grade Farmer's Friend, ...	8.73	3.64	3.30-4.12	4.00	1.74	1.84	7.58	6-8	5.74	5-6	10.12		10-11*	
225	Ammoniated Bone Superphosphate,	10.51	2.38	2.47-3.30	3.74	5.74	3.60	13.08	10-12	9.48	9-11	3.20		2-3	
239	Dry Fish Guano, ...	15.85	8.02	7.41-9.06	—	4.46	3.08	7.54	7-9	4 46	—	—		—	
273	Vegetable Bone Superphosphate, ..	10 96	5.17	5.00-6.00	4.58	1.72	.94	7.24	7-9	6.30	6-7	6.80		5.94-8	
												Mechanical Analysis.			
												Fine.	Med. Fine.	Med.	Coarse Med.
	Bones.														
29-30	Pure Gro'nd Raw Knuckle Bone Meal	7.57	3.95	3.79-4.00	—	7.94	17.52	25.46	24.7-25.6	7.94	—	59.00	39.50	1.50	—
32	Strictly Pure Fine Bone.	9.90	4.13	3.79-4.00	—	5.88	16.00	21.88	22-23	5.88	—	31.09	33.90	31.21	3.80
41	Pure Bone Meal.	13.23	2.42	2.47-4.12	—	8.54	14.64	23.18	20-25	8.54	—	63.40	21.90	14.70	—
104	Ground Raw Bone, ...	5.62	3.73	3.30-3.71	—	8.18	14.46	22.64	22-25	8.18	—	39.10	41.70	19.20	—
120	Fresh Ground Bone, ...	6.11	3.34	2.50-3.50	—	10.30	8.60	18.90	18-22	10.30	5-7	61.60	21.70	16.70	—
121-265	Pure Ground Bone, ...	4.80	2.00	2.50	—	12.50	14.54	27.04	25.56	12.50	—	67.52	15.60	11.76	5.12
157	Fine Ground Bone, ...	3.97	1.92	2.00	—	9.34	20.08	29.42	29.21	9.34	—	82.50	13.10	4.40	—
180	Pure Ground Bone, ...	11.77	2.36	2.06-2.88	—	8.24	15.36	23.60	16-20	8.24	1 2	65.84	21.66	12.50	—
193-264	Fine Ground Bone, ...	5.35	3.16	2.50-3.25	—	1.78	18.68	20.46	21-23	1.78	—	59.50	27.24	13.26	—
257	Pure Ground Bone, ...	6.62	4.31	3.00-4.00	—	16.90	14.46	21.36	20-26	16.90	12.28	19.12	14.08	15.30	51.50
260	Fine Ground Bone, ...	5.85	2.15	2.88-3.30	—	10.82	13.38	24.20	24-26	10.82	—	75.92	12.86	11.22	—
262	Pure Ground Bone, ...	3.28	2.58	2.00-3.00	—	8.18	18.32	26.74	27-29	8.18	—	56.80	29.10	14.10	—
267	Pure Bone Meal, ...	6.67	3.73	2.47-4.12	—	5.50	15.36	20.86	20-25	5.50	—	43.00	35.80	21.20	—
280	Pure Ground Bone,	5.30	3.81	2.90-3.70	—	6.02	19.06	25.08	25	6.02	—	37.89	26.61	24.50	11.00

*Sulphate of Potash, the source of Potash.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1895. *Cents per pound.*
Nitrogen in ammonia salts,	18.5
“ “ nitrates,	15.
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	16.5
“ “ “ cotton-seed meal,	12
“ “ “ fine ground bone and tankage,	16
“ “ “ fine ground medium bone and tankage,	14
“ “ “ medium bone and tankage,	11
“ “ “ coarse bone and tankage,	5
“ “ “ hair, horn-shavings and coarse fish scraps,	5
Phosphoric acid soluble in water,	6
“ “ soluble in ammonium citrate,	5½
“ “ in fine bone and tankage,	5½
“ “ in fine medium bone and tankage,	4½
“ “ in medium bone and tankage,	3
“ “ in coarse bone and tankage,	2
“ “ in fine ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	5
“ “ insoluble (in am. cit.) in mixed fertilizers,	2
Potash as High Grade Sulphate, and in mixtures free from Muriate,	5¼
“ “ Muriate,	4½

The manurial constituents contained in feedstuffs are valued as follows:

Organic Nitrogen,	12
Phosphoric acid,	5
Potash,	5

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS
AGRICULTURAL COLLEGE.

BULLETIN NO. 33.

GLOSSARY OF FODDER TERMS.

OCTOBER, 1895.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1895.

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OF THE

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AMHERST, MASS.

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Hatch Experiment Station, Amherst, Mass.

A Partial Glossary of Fodder Terms.

E. B. HOLLAND.

ACIDS, INORGANIC.—Inorganic acids are combinations of the non-metals (chlorine, phosphorus, etc.) with hydrogen, or with hydrogen and oxygen. They possess an entremely sour taste. The most common are hydrochloric, (muriatic,) phosphoric, sulphuric and nitric acids.

ACIDS, ORGANIC.—These are chemical combinations of carbon, oxygen and hydrogen, generally possessing a sour taste. United to potash, lime, etc., they form organic salts. Organic acids are found as a rule dissolved in the plant juices, and to the largest extent in fruit, silage and green coarse feeds. The most common ones are tartaric, citric, malic, oxalic, acetic and lactic acids Their exact value as a source of nutrition is unknown.

Organic Acids have as a rule a favorable effect upon the palatability of a food.

ALBUMINOIDS.—Albuminoids are distinct groups of nitrogen containing substances found in all plants and seeds. Their most common forms are seen in the gluten of the grains, albumen (white) of the egg, and curd of the milk. They appear in large quantities in seeds and by-products derived from them, such as cotton, linseed, gluten and bean meals. The elementary composition of these bodies is carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus. As a food they serve as the *exclusive source* of production of flesh, muscle, ligaments, tendons, hide, etc., and of repair of bodily wastes.

Albuminoids are also a source of energy and were formerly considered a source of fat, but this is now doubted.

ALKALOIDS.—Alkaloids are also nitrogen containing substances, but very different from the albuminoids, occurring in certain distinct plants and possessing poisonous or narcotic properties. They are represented by caffeine in coffee and nicotine in tobacco.

ALKALIES.—Alkalies are distinct combinations of oxygen and hydrogen with potassium, sodium, etc. The three common alkalies are potash, soda and ammonia. In common usage, lime, magnesia, etc., are classed as alkalies. They are directly the opposite of acids and unite with them to form neutral bodies called salts.

ALUMINA.—Alumina is a metallic substance, rarely present in plants excepting traces in the roots and leaves.

AMIDES.—Amides are partially formed albuminoids, occurring largely in solution in the juices of immature plants, root crops, and silage. In feeding value, however, they are inferior to the albuminoids, but when there is a deficiency in these latter compounds, the amides (especially asparagin, the most common one) seem to act in two directions,—as a partial substitute for the albuminoids, and as a body favoring the thorough digestion of the carbohydrates.

AMMONIA.—Ammonia is a pungent gas, arising from the decay of all nitrogenous substances such as flesh, horn, horse manure, etc. Traces of ammonia are sometimes present in plants, perhaps due to slight disintergration of the intercellular mass or to incomplete assimilation. It is of no nutritive value, as shown by the direct feeding of ammonia salts.

ASH, CRUDE.—The ash constitutes the inorganic or mineral matter of a plant. It is the portion which remains after burning, the ingredients of which are potash, soda, lime, magnesia, iron, alumina, manganese, sulphuric and phosphoric acids, chlorine, silica, etc. The basic or metallic substances (the first seven named), occur in the plant combined with other inorganic and organic elements.

In nutrition these various constituents serve to build up the bony structure, and are to a limited extent a necessary component of the tissues and organs.

ASPARAGIN.—Asparagin is the most important amide present in plants.

CALORICS.—The caloric is a standard unit of heat. (French). It is the amount required to raise the temperature of one kilogram (2.2 lbs.) of water through 1.8° Fahr., and is equivalent in mechanical energy to 1.53 foot-tons. The caloric is used by physiologists to express the comparative amounts of vital energy that the different feeds can produce, when consumed by the animal.

CARBOHYDRATE.—The term carbohydrate is applied inclusively to cellulose and to all such compounds as sugars, starches, gums, etc., usually grouped under the head of "nitrogen free extract." Their component elements are carbon, hydrogen and oxygen, and the digestible portions are considered of equal value and perform the same function in animal nutrition.

CARBON.—Free carbon occurs in the form of diamond, graphite, coal, etc. It is the foundation element of all organic substances, in which it exists in close chemical union with other elements such as oxygen, hydrogen and sometimes nitrogen, phosphorus and sulphur.

CELLULOSE.—See Fibre, crude.

CHLORINE.—Chlorine is an inorganic acid-forming element, usually present in plants, but only to a limited extent. It is one of the two constituents of common salt.

CHLOROPHYLL.—Chlorophyll is the green pigment which produces the characteristic color of ordinary plants. From a nutritive standpoint it is of no value, being practically indigestible.

Cholesterine.—Cholesterine is a substance somewhat resembling fat of an uncertain nutrient value.

Dextrin.—Dextrin is an intermediate product between starch and sugar.

Digestive Co-efficient.—A digestive co-efficient is a figure indicating the percentage of a food ingredient which can be digested and assimilated by an animal—the same having been deduced from actual experiment.

Dry Matter.—Dry matter signifies a material free from water.

Ether Extract.—Ether extract is that portion of the plant soluble in ether. It comprises the group of fatty substances, occurring in the largest amounts in seeds and by-products, such as gluten, corn germ, cotton seed, and bean meals.

Among these ether soluble bodies may be mentioned neutral fats, free fatty acids, vegetable wax, resins, cholesterine, lecithin, and coloring matters such as chlorophyll, etc.

As a nutrient, ether extract produces heat and energy for bodily warmth and force to run the mechanism, serves to prevent undue waste of albuminoids, and when in excess is transformed into animal fat.

Fat, Crude.—Same as ether extract.

Feeding Standards.—Feeding standards are definite combinations of the several groups of nutrients (protein, fat, and carbohydrates) to be fed daily to farm animals in order to attain specific ends. These standards are deduced from the results of a large number of carefully conducted feeding experiments.

Fibre, Crude.—By crude fibre or crude cellulose is meant the woody structure or frame work of plants. As a nutrient it produces heat and energy, acts as an economizer of protein, and when in excess of bodily needs is transformed into fatty tissues.

Fodder Ration.—A fodder ration is a distinct amount by weight of coarse fodders and concentrated feeds, so proportioned as to secure a definite feeding standard.

Glyceride.—Glyceride is but another term for ordinary fats. Chemically speaking a fat is a combination of fatty acids with glycerine.

Gums.—Gums are classified with the carbohydrates and so far as digestible have an equal food value.

Hydrocarbons.—Hydrocarbons are bodies composed of carbon and hydrogen, but rarely present to any extent in ordinary feed stuffs.

Hydrogen.—Hydrogen in its natural state is the lightest of all gases; when combined with carbon, oxygen and sometimes with nitrogen, sulphur and phosphorus it forms all kinds of organic substances.

Iron.—Iron is a metallic element, always present in plants, and entering into the composition of blood corpuscles, etc.

Lecithin.—Lecithin is a body somewhat resembling fat, though it contains both nitrogen and phosphorus.

Lignin.—Lignin is a substance probably of an acid character which united with cellulose forms the hard woody part of the plant. In itself it is of little or no nutrient value, being almost wholly indigestible, and furthermore, it prevents to a considerable degree the digestion of other constituents, especially cellulose.

Lime.—Lime is a valuable component of plant ashes, being always present. It is one of the chief constituents of bone.

Magnesia.—Magnesia is an inorganic substance, somewhat resembling lime, always present in plants.

Manganese.—Manganese is a comparatively rare inorganic element, of which traces are occasionally found in plants.

Nitrates.—By nitrate is meant a combination of nitric acid with a so-called base such as soda or potash. Thus nitrate of soda or nitrate of potash are spoken of as nitrates.

Nitric Acid.—This is one of the most important of the inorganic or mineral acids and is a combination of hydrogen, oxygen and nitrogen. It is present in all field and garden crops, being especially noticeable in beets, turnips, and the like. Nitrogen enters the plant through the roots chiefly in this form.

Nitrogen.—Nitrogen in its natural state is an inert gas. It exists however, combined with a variety of other elements. It is the characteristic element of the albuminoids as well as of nitric acid and ammonia.

Nitrogen-Free Extract.—Nitrogen-free extract includes all the organic nitrogen-free compounds of feed stuffs,—except crude fibre and the ether extract group,—such as cane and grape sugars, starch, dextrin, gum, lignin, coloring matter, organic acids, etc.

Of these various substances, the sugar, dextrin, starch, gums, have the same nutritive effect, so far as digestible, the others being of an inferior value.

As a nutrient, nitrogen-free extract produces heat and energy, serves as an albuminoid economizer, and an excess is transformed into fatty tissues.

Nutrients.—A nutrient is any digestible food constituent which builds up the body or repairs its wastes, produces heat for bodily warmth or energy for carrying on its processes.

The four great groups of nutrients are ash, protein, fat, and carbohydrates.

NUTRITIVE RATIO.—By nutritive ratio is meant simply the proportion by weight of the digestible carbohydrates and fat, to the protein, the latter being taken as unity. It has been demonstrated by experiment that, other things being equal, the best returns can be secured in case of milch cows for example if the various feeds are so combined as to produce a ration containing 4.5 to 5.5 as much carbohydrates and fat, as protein, or in other words rations having a nutritive ratio of 1 protein to 4.5 to 5.5 carbohydrates and fat (1 :4.5 or 1 : 5.5.)

CALCULATING A NUTRITIVE RATIO.

In calculating a nutritive ratio, it is necessary to multiply the amount of fat by $2\frac{1}{2}$ to give it a value corresponding to carbohydrates because the fat furnishes $2\frac{1}{2}$ times as much energy as do carbohydrates. Suppose a fodder ration to contain the following amounts of digestible nutrients :—

Digestible protein	2.70 lbs.
" fat	0.73 "
" carbohydrates	12.60 "
Total digestible	16.03 lbs.

According to our definition the nutritive ratio would be found as follows :

Carbohydrates	12.60 lbs.
Fat .73 lb. × $2\frac{1}{2}$ =	1.82 "
Total for fat and carbohydrates	14.42 lbs.

14.42 lbs. carbohydrates ÷ by 2.7 lbs. protein=5.34 or as 1 part of protein is to 5.34 parts of carbohydrates (1 : 5.34).

ORGANIC MATTER.—The organic matter of a plant or feed. as the term is used, signifies that portion, which can be burned, the elementary composition of which is carbon, hydrogen, oxygen, and nitrogen, which in the plant are more or less intimately associated with inorganic elements.

OXYGEN.—Oxygen in its natural state is a gas. When united with other elements it forms many of the most important organic and inorganic substances.

PECTIN.—Pectin is the jelly-forming compound of many fruits.

PENTOSANS.—Pentosans are substances found in the woody portions of plants, closely identified with the cellulose.

PHOSPHORIC ACID.—Phosphoric acid is a combination of oxygen, hydrogen and phosphorus. It is usually found in plants, combined with lime and magnesia and is usually stored up in the largest quantity in the seed. Phosphate of lime forms the principal mineral part of bone.

Phosphorus is an inorganic element, being the characteristic ingredient of phosphoric acid.

POTASH.—Potash is one of the inorganic bases or substances found in all plants, usually in combination with phosphoric or one of the organic acids.

POTENTIAL ENERGY.—The potential energy of a fodder or ration is the sum of the heat producing power of its digestible constituents, expressed in terms of the caloric (or foot-tons).

PROTEIN, CRUDE.—By the term protein is meant practically all the nitrogen-containing substance present in ordinary agricultural plants, chief of which, in point of prominence and nutritive value, are the albuminoids, with amides forming the secondary compounds. (See also albuminoids.)

RATION.—A ration is a food mixture. (See Fodder Rations.)

RESINS.—Resins are organic bodies especially rich in carbon and hydrogen, but poor in oxygen. They occur but very little in agricultural plants.

SALT.—Salt is a combination of sodium and chlorine. As an adjunct to a ration, it assists digestion by increasing the secretion of gastric juice and by hastening the diffusion of liquids.

SILICA.—Silica is an inorganic substance deposited in the stem, leaves, and outer bark of many plants.

It has no direct nutritive value.

SAND.—Sand is fragments of crystals of silica.

SODA.—Soda is one of the alkalies, usually present in plants; and is also a constituent of common salt.

STARCH.—Starch is a combination of carbon, hydrogen and oxygen and is an important carbohydrate. It is changed to sugar during the process of digestion.

SUGARS.—In chemical composition sugars very closely resemble starch. They are soluble in water and entirely digested.

SULPHURIC ACID.—Sulphuric acid is a combination of sulphur, oxygen and hydrogen. United to lime, potash, etc., it forms sulphates.

WATER.—Water is a constituent of all feeds. Chemically it is a combination of hydrogen and oxygen. On its presence, to a considerable degree, depend the succulency and palatability of a feed. It is of the first importance in promoting the solution, digestion, and assimilation of the nutrients, and the excretion of waste products.

WAX.—Wax is of limited occurrence in ordinary fodder plants, and is of little or no nutritive value.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 34.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

II. ANALYSES OF LICENSED FERTILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1895.

OCTOBER, 1895.

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DIVISION OF CHEMISTRY.

C. A. Goessmann.

I. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

92—93.

REFUSE OF MADDER.

I. Sent on from Lawrence, Mass.
II. Sent on from Boston, Mass.

	Per cent. I.	II.
Moisture at 100° C.	12.20	11.66
Phosphoric acid,	.36	.34
Potassium oxide,	2.24	2.56
Nitrogen,	.90	.91
Calcium oxide,	3.67	4.20
Magnesium oxide,	.36	.65
Insoluble matter,	4.42	4.92

94—96.

COTTON SEED MEAL.

I, II, and III sent on from North Hatfield, Mass.

		Per cent.	
	I.	*II.*	*III.*
Moisture at 100° C.	9.49	8.59	9.06
Nitrogen,	7.17	7.63	6.28
Phosphoric acid,	2.39	2.39	2.39
Potassium oxide,	1.73	1.73	1.73

97—99.

I. Lime-kiln ashes. Sent on from Sunderland, Mass.
II. Bituminous Coal ashes. Sent on from Shirley, Mass.
III. Harvester Fertilizer. Collected at Worcester, Mass.

		Per cent.	
	I.	*II.*	*III.*
Moisture at 100° C.	1.02	7.18	.62
Phosphoric acid,	.72	.43	.62
Potassium oxide,	2.78	.60	Trace
Calcium oxide,	41.99	*	53.24
Insoluble matter,	7.87	68.50	*

*Not determined.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1895, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Chemicals.		
11	Nitrate of Soda,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
13	Muriate of Potash,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
20	Sulphate of Ammonia,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
21	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
22	Sulphate of Potash "High Grade,"	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
24	Sulphate of Potash "Low Grade,"	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
25	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
38	Sulphate of Potash "Low Grade,"	Bradley Fertilizer Co., Boston, Mass.,	Springfield.
39	Nitrate of Soda,	Williams & Clark Fertilizer Co., Boston, Mass.,	Springfield.
40	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Springfield.
44	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
45	Sulphate of Potash "Low Grade,"	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
46	Sulphate of Potash "High Grade,"	Bradley Fertilizer Co , Boston, Mass.,	Worcester.
47	Sulphate of Potash "Low Grade,"	Williams & Clark Fertilizer Co.. Boston, Mass.,	Springfield.
70	Sulphate of Potash "Low Grade,"	Quinnipiac Co., Boston, Mass.,	Springfield.
71	Nitrate of Soda,	Clark's Cove Fertilizer Co.,Boston,Mass.,	Springfield.
80	Sulphate of Potash "High Grade,"	Quinnipiac Co., Boston, Mass.,	Springfield.
83	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
84	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
88	Sulphate of Potash "High Grade,"	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
91	Muriate of Potash,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
100	Sulphate of Potash "Low Grade,"	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
138	Nitrate of Soda,	Quinnipiac Co., Boston, Mass.,	Springfield.
140	Sulphate of Potash "Low Grade,"	Lucien Sanderson, New Haven, Conn.,	Springfield.
160	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass ,	Worcester.
162	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Worcester.
165	Nitrate of Soda,	Lucien Sanderson, New Haven, Conn.,	Springfield.
169	Muriate of Potash,	Lucien Sanderson, New Haven, Conn.,	Springfield.
171	Sulphate of Potash "High Grade,"	Bowker Fertilizer Co., Boston, Mass.	Worcester.
191	Sulphate of Potash "High Grade,"	L. B. Darling Fertilizer Co., Pawtucket, R. I ,	Dighton.
198	Muriate of Potash,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
237	Sulphate of Potash "High Grade,"	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
245	Nitrate of Soda,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
258	Sulphate of Ammonia,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
268	Muriate of Potash,	Quinnipiac Co., Boston, Mass.,	Fitchburg.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Potassium Oxide in 100 lbs.		Moisture in one ton of Fertilizer.		Nitrogen in one ton of Fertilizer.		Potassium Oxide in one ton of Fertilizer.	
			Found.	Guaranteed.	Found.	Guaranteed.	Lbs.	O's.	Lbs.	O's.	Lbs.	O's.
	Compound Fertilizers.											
11	Nitrate of Soda, ...	1.72	15.60	15.48-15.81	—	—	34	6	312	—	—	—
13	Muriate of Potash,................	.37	—	—	51.72	50-52	7	6	—	—	1034	6
20	Sulphate of Ammonia, ...	.97	20.52	19.78-20.60	—	—	19	6	410	6	—	—
21-84-162	Nitrate of Soda, ...	1.57	15.61	15.64-16.14	—	—	31	6	312	3	—	—
22-171	Sulphate of Potash, "High Grade,"	.93	—	—	49.16	48-52	18	10	—	—	983	3
24	Sulphate of Potash, " Low Grade,"	3 .76	—	—	25.81	24-26	75	3	—	—	516	3
25-83-160	Muriate of Potash,................	1.91	—	—	51.33	50-52	38	3	—	—	1026	10
38-45	Sulphate of Potash, " Low Grade,"	6.55	—	—	27.76	23-28	131	—	—	—	555	3
39	Nitrate of Soda, ...	1.47	15.39	15.48-15.81	—	—	29	6	307	13	—	—
40-44	Muriate of Potash,................	1.27	—	—	50.24	50-53	25	6	—	—	1004	13
46	Sulphate of Potash, "High Grade,"	.75	—	—	50.80	50-52	15	—	—	—	1016	—
47	Sulphate of Potash " Low Grade,'"	3.62	—	—	24.80	25.94-28.10	73	6	—	—	496	—
70	Sulphate or Potash, " Low Grade,'	10.83	—	—	27.60	27.02-29.72	210	10	—	—	552	—
71	Nitrate of Soda, ...	1.37	15.89	15.64-16.48	—	—	27	6	317	12	—	—
80	Sulphate of Potash, " High Grade,"	.49	—	—	49.00	48.63-51.34	9	13	—	—	980	—
88	Sulphate of Potash, " High Grade,"	.69	—	—	50.22	48.63-51.34	13	13	—	—	1004	6
91	Muriate of Potash, ...	1.30	—	—	51.64	50.54-53.70	26	—	—	—	1032	13
100	Sulphate of Potash, "Low Grade,"	4.07	—	—	27.16	25.94-28.10	81	6	—	—	543	3
138	Nitrate of Soda, ...	1.31	16.00	15.48-15.81	—	—	26	3	320	—	—	—
140	Sulphate of Potash, " Low Grade,"	2.58	—	—	25.80	27.02-29.72	51	10	—	—	516	—
165	Nitrate of Soda, ...	1.17	15.94	15.64-16.48	—	—	23	6	318	13	—	—
169	Muriate of Potash,................	.97	—	—	48.56	50.54-53.70	19	6	—	—	971	3
191	Sulphate of Potash, "High Grade,"	.63	—	—	51.30	—	12	10	—	—	1026	—
198-268	Muriate of Potash,................	1.75	—	—	50.84	50.54-53.70	35	—	—	—	1016	13
237	Sulphate of Potash, "High Grade,"	.02	—	—	48.70	48.63-51.34	—	6	—	—	974	—
245	Nitrate of Soda, ...	.95	15.89	14.83-16.48	—	—	19	—	317	13	—	—
258	Sulphate of Ammonia, ...	1.32	20.10	20.18-21.00	—	—	26	6	402	—	—	—

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1895, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY NO.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT
	Compound Fertilizers.		
2	Almont Brand Ammoniated Guano,	Powers, Gibbs & Co., Wilmington, N. C.,	Amherst.
6	Bone, Blood and Potash,	Armour & Co., Chicago, Ill.,	Amherst.
18	Dissolved Bone Black,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
27	Soluble Tobacco Manure,	Rogers & Hubbard Co., Middletown, Conn.,	Amherst.
48	Chemical Compound Lawn Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Springfield.
61	Chemical Compound Corn Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Springfield.
65	Chemical Compound Lawn Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Amherst.
66	Homestead Chemical Compound Lawn Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Amherst.
74	Complete Lawn Dressing,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
101	Complete Manure for Grass and Grain,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
106	Dry Ground Fish Guano,	Leander Wilcox, Mystic, Conn.,	Amherst.
113	Four-fold Fertilizer,	Walker Stratman & Co., Pittsburg, Pa.,	Amherst.
128	Ammoniated Bone Superphosphate,	E. Frank Coe & Co., New York, N. Y.,	Westfield.
133	Complete Manure for Grass and Grain,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
159	Chemical Compound Lawn Fertilizer,	Mason, Chapin & Co., Providence, R. I.,	Taunton.
179	Dry Ground Manhaden Fish Guano,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
195	Economical Manure,	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Dighton.
202	Complete Lawn Dressing,	H. J. Baker & Bro., New York, N. Y.,	Pittsfield.
207	High Grade Potato Manure,	E. Frank Coe & Co., New York, N. Y.,	Lee.
209	Chittenden's Ammoniated Phosphate,	National Fertilizer Co., Bridgeport, Conn.,	Pittsfield.
210	Bone, Blood and Potash,	Armour & Co., Chicago, Ill.,	Pittsfield.
213	Vegetable and Vine Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	Pittsfield.
216	Fish and Potash,	Read Fertilizer Co., Syracuse, N. Y.,	W. Springfield.
226	Dry Ground Fish,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
230	Market Garden Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	W. Springfield.
238	Potato, Hop and Tobacco Manure,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Lee.
241	Potato and Tobacco Manure,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
255	Peruvian Guano,	Mapes Formula & Peruvian Guano Co., New York, N.Y	Boston.
266	Potato, Hop and Tobacco Manure,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Fitchburg.
274	High Grade Fish and Potash,	Russia Cement Co., Gloucester, Mass.,	Lawrence.
277	Special Potato Fertilizer,	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.,	Fitchburg.
282	Wood Ashes,	Forest City Wood Ash Co., Boston, Mass.,	No. Amherst.
	Bones.		
8	Bone Meal,	Armour & Co., Chicago, Ill.,	Amherst.
221	Bone Meal,	Armour & Co., Chicago, Ill.,	Pittsfield.
290	Ground Bone,	Edmund Hersey, Hingham, Mass.	Amherst.

<table>
<tr><th rowspan="3">Laboratory Number.</th><th rowspan="3">Name of Brand.</th><th rowspan="3">Moisture.</th><th colspan="2">Nitrogen in 100 lbs.</th><th colspan="7">Phosphoric Acid in 100 lbs.</th><th colspan="4" rowspan="2">Potassium Oxide in 100 lbs.</th></tr>
<tr><th rowspan="2">Found.</th><th rowspan="2">Guaranteed.</th><th rowspan="2">Soluble.</th><th rowspan="2">Reverted.</th><th rowspan="2">Insoluble.</th><th colspan="2">Total.</th><th colspan="2">Available.</th></tr>
<tr><th>Found.</th><th>Guaranteed.</th><th>Found.</th><th>Guaranteed.</th><th colspan="2">Found.</th><th colspan="2">Guaranteed.</th></tr>
<tr><td></td><td>*Compound Fertilizers.*</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>2</td><td>Almont Brand Ammoniated Guano,</td><td>6.43</td><td>.86</td><td>.82-1.65</td><td>6.84</td><td>.48</td><td>1.26</td><td>8.58</td><td>—</td><td>7.32</td><td>8-10</td><td colspan="2">3.72</td><td colspan="2">3-4</td></tr>
<tr><td>6-210</td><td>Bone, Blood and Potash, ...</td><td>4.88</td><td>4.34</td><td>4.12-4.94</td><td>1.50</td><td>5.55</td><td>6.35</td><td>13.40</td><td>12-14</td><td>7.05</td><td>8-10</td><td colspan="2">7.36</td><td colspan="2">6.75-7.83</td></tr>
<tr><td>18</td><td>Dissolved Bone Black, ...</td><td>14.49</td><td>—</td><td>—</td><td>13.94</td><td>1.54</td><td>·08</td><td>15.56</td><td>—</td><td>15.48</td><td>15-18</td><td colspan="2">—</td><td colspan="2">—</td></tr>
<tr><td>27</td><td>Soluble Tobacco Manure, ...</td><td>8.66</td><td>5.13</td><td>5-6</td><td>1.12</td><td>5.73</td><td>3.92</td><td>10.77</td><td>10-12</td><td>6.85</td><td>7.4-8.5</td><td colspan="2">10.16</td><td colspan="2">10-11*</td></tr>
<tr><td>48-65-159</td><td>Chemical Compound Lawn Fert'zer,</td><td>3.43</td><td>4.89</td><td>4.80</td><td>—</td><td>10.22</td><td>9.28</td><td>19.50</td><td>—</td><td>10.22</td><td>12.</td><td colspan="2">.56</td><td colspan="2">.75-2.00</td></tr>
<tr><td>61</td><td>Chemical Compound Corn Fert'zer,</td><td>14.54</td><td>1.96</td><td>1.46</td><td>.38</td><td>1.28</td><td>9.98</td><td>11.64</td><td>16.36</td><td>1.66</td><td>—</td><td colspan="2">.24</td><td colspan="2">—</td></tr>
<tr><td>66</td><td>Homestead Chem. Comp. Lawn Fert.</td><td>7.93</td><td>4 29</td><td>5.4-8.00</td><td>—</td><td>5.52</td><td>.52</td><td>6.04</td><td>5.6-7.5</td><td>5.52</td><td>—</td><td colspan="2">1.20</td><td colspan="2">1.00-3.00</td></tr>
<tr><td>74-202</td><td>Complete Lawn Dressing, ...</td><td>12.21</td><td>3.88</td><td>3.50</td><td>.20</td><td>5.16</td><td>.94</td><td>6.30</td><td>—</td><td>5.36</td><td>4.25</td><td colspan="2">8.44</td><td colspan="2">6-7</td></tr>
<tr><td>101-133</td><td>Complete Manure for Grass & Grain,</td><td>8.58</td><td>3.95</td><td>4.08-4.76</td><td>1.41</td><td>5.32</td><td>1.10</td><td>7.83</td><td>11-14</td><td>6.73</td><td>10-12</td><td colspan="2">3.17</td><td colspan="2">2.5-3.5</td></tr>
<tr><td>106</td><td>Dry Ground Fish Guano, ...</td><td>9.08</td><td>8.59</td><td>8.5-10.00</td><td>—</td><td>4.32</td><td>3.54</td><td>7.86</td><td>—</td><td>4.32</td><td>4-6</td><td colspan="2">—</td><td colspan="2">—</td></tr>
<tr><td>113</td><td>Four-Fold Fertilizer, ...</td><td>9.35</td><td>1.44</td><td>.82-1.65</td><td>5.48</td><td>2.58</td><td>4.88</td><td>10.88</td><td>11-14</td><td>8.06</td><td>8-10</td><td colspan="2">1.36</td><td colspan="2">1-2*</td></tr>
<tr><td>128</td><td>Ammoniated Bone Superphosphate,</td><td>11.50</td><td>2.27</td><td>2.06-2.47</td><td>7.14</td><td>1.90</td><td>2.68</td><td>11.72</td><td>11-13</td><td>9.04</td><td>9-12</td><td colspan="2">1.52</td><td colspan="2">1.85</td></tr>
<tr><td>179</td><td>Dry Ground Manhaden Fish Guano,</td><td>12.80</td><td>7.87</td><td>8.24-9.88</td><td>—</td><td>2.28</td><td>4.88</td><td>7.70</td><td>6.87-9.16</td><td>2.28</td><td>—</td><td colspan="2">—</td><td colspan="2">—</td></tr>
<tr><td>195</td><td>Economical Manure, ...</td><td>14.86</td><td>2.60</td><td>2.47-3.30</td><td>5.42</td><td>2.84</td><td>.38</td><td>8.64</td><td>8-10</td><td>8.26</td><td>6-8</td><td colspan="2">8.68</td><td colspan="2">8-10</td></tr>
<tr><td>207</td><td>High Grade Potato Manure, ...</td><td>9 29</td><td>1.99</td><td>2.06-2.88</td><td>6.80</td><td>.92</td><td>2.82</td><td>10.54</td><td>9-11</td><td>7.72</td><td>8-11</td><td colspan="2">5.96</td><td colspan="2">6-7</td></tr>
<tr><td>209</td><td>Chittenden's Ammoniated Phosph'te</td><td>15.76</td><td>2.37</td><td>2.-3.</td><td>1.28</td><td>8.76</td><td>1.16</td><td>11.20</td><td>9-11</td><td>10.04</td><td>7-8</td><td colspan="2">2.12</td><td colspan="2">2-3</td></tr>
<tr><td>213</td><td>Vegetable and Vine Fertilizer, ...</td><td>11.19</td><td>1.97</td><td>1.65-2.47</td><td>4.50</td><td>1.64</td><td>.46</td><td>6.60</td><td>5.5-6.5</td><td>6.14</td><td>5.5-6.5</td><td colspan="2">12.68</td><td colspan="2">12-13</td></tr>
<tr><td>216</td><td>Fish and Potash, ...</td><td>10.00</td><td>2.51</td><td>2.47-3.30</td><td>—</td><td>3.94</td><td>2.04</td><td>5.98</td><td>6-7</td><td>3.94</td><td>4-6</td><td colspan="2">5.60</td><td colspan="2">4-6</td></tr>
<tr><td>226</td><td>Dry Ground Fish, ...</td><td>10.80</td><td>7.54*</td><td>7.41-9.06</td><td>—</td><td>4.35</td><td>3.90</td><td>8.25</td><td>7-9</td><td>4.35</td><td>—</td><td colspan="2">—</td><td colspan="2">—</td></tr>
<tr><td>230</td><td>Market Garden Fertilizer, ...</td><td>10.08</td><td>3.05</td><td>2.47-3.30</td><td>3.96</td><td>3.68</td><td>2.50</td><td>10.14</td><td>8-12</td><td>7.64</td><td>6-8</td><td colspan="2">9.44</td><td colspan="2">10-12*</td></tr>
<tr><td>238-266</td><td>Potato, Hop and Tobacco Manure,</td><td>13.02</td><td>2.12</td><td>2-3</td><td>7.30</td><td>2.34</td><td>1.38</td><td>11.02</td><td>10-12</td><td>9.64</td><td>10-12</td><td colspan="2">3.16</td><td colspan="2">3.25-4.25</td></tr>
<tr><td>241</td><td>Potato and Tobacco Manure, ...</td><td>12.95</td><td>2.20</td><td>2.06-2.88</td><td>4.84</td><td>4.22</td><td>2.86</td><td>11.92</td><td>9-13</td><td>9.06</td><td>8-11</td><td colspan="2">3.40</td><td colspan="2">3-4*</td></tr>
<tr><td>255</td><td>Peruvian Guano, ...</td><td>9.58</td><td>8.16</td><td>8.24</td><td>.74</td><td>7.58</td><td>4.34</td><td>12.66</td><td>13.</td><td>8.32</td><td>—</td><td colspan="2">2.00</td><td colspan="2">—</td></tr>
<tr><td>274</td><td>High Grade Fish and Potash, ...</td><td>12.45</td><td>3.18</td><td>2.47-3.30</td><td>—</td><td>8.96</td><td>2.56</td><td>11.52</td><td>10-12</td><td>8.96</td><td>9-10</td><td colspan="2">4.68</td><td colspan="2">4-6</td></tr>
<tr><td>277</td><td>Special Potato Fertilizer, ...</td><td>8.55</td><td>3.87</td><td>3.7-4.5</td><td>6.60</td><td>2.04</td><td>1.64</td><td>10.28</td><td>—</td><td>8.64</td><td>8-9</td><td colspan="2">5.44</td><td colspan="2">5.4-6.4</td></tr>
<tr><td>282</td><td>Wood Ashes, ...</td><td>13.85</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>1.66</td><td>1.5-2.5</td><td>—</td><td>—</td><td colspan="2">5.44</td><td colspan="2">4.5-8.00</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Mechanical Analysis.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Fine.</td><td>Med. Fine.</td><td>Med.</td><td>Coarse Med.</td></tr>
<tr><td></td><td>*Bones.*</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8-221</td><td>Bone Meal, ...</td><td>13.35</td><td>2.41</td><td>2.47-3.30</td><td>—</td><td>8.48</td><td>18.34</td><td>26.82</td><td>25-28</td><td>8.48</td><td>—</td><td>68.35</td><td>20.30</td><td>9.20</td><td>2.15</td></tr>
<tr><td>290</td><td>Ground Bone, ...</td><td>4.00</td><td>3.20</td><td>3-4</td><td>—</td><td>8.26</td><td>15.74</td><td>24.00</td><td>19-25</td><td>8.28</td><td>—</td><td>33.77</td><td>23.00</td><td>21.50</td><td>11.73</td></tr>
</table>

*Correction from June Bulletin.

PER CENTS OF DIFFERENT INGREDIENTS FOUND IN THE PRECEDING TABLE OF ANALYSES OF FERTILIZERS CALCULATED TO POUNDS AND OUNCES PER TON (2000 lbs.)

Laboratory Number.	NAME OF BRAND.	Moisture in one ton of Fertilizer		Nitrogen in one ton of Fertilizer		Phosphoric Acid in one ton of Fertilizer.								Potassium Oxide in one ton of Fertilizer	
						Soluble.		Reverted.		Insoluble		Total.			
		Lbs.	O's.	Lbs.	O's.	Lbs.	O's.	Lbs.	O's.	Lbs.	O's.	Lbs.	O's.	Lbs.	O's.
2	Almont Brand Ammoniated Guano,	128	10	17	3	136	13	9	10	25	3	171	10	74	6
6-210	Bone, Blood and Potash,	97	10	86	13	30	—	111	—	127	—	268	—	147	3
18	Dissolved Bone Black.	289	13	—	—	278	13	30	13	1	10	311	3	—	—
27	Soluble Tobacco Manure,	173	3	102	10	22	6	114	10	78	6	215	6	203	3
48-65-150	Chemical Compound Lawn Fertilizer,	68	10	97	13	—	—	204	6	185	10	390	—	11	3
61	Chemical Compound Corn Fertilizer,	290	13	39	3	7	10	25	10	199	10	232	13	4	13
66	Homestead Chemical Compound Lawn Fertilizer,	158	10	85	13	—	—	110	6	10	6	120	13	24	—
74-202	Complete Lawn Dressing,	244	3	77	10	4	—	103	3	18	13	126	—	168	13
101-133	Complete Manure for Grass and Grain,	171	10	79	—	28	3	106	6	22	—	156	10	63	6
106	Dry Ground Fish Guano,	181	10	171	13	—	—	86	6	70	13	157	3	—	—
113	Four-fold Fertilizer,	187	—	28	13	109	10	51	10	56	6	217	10	27	3
128	Ammoniated Bone Superphosphate,	230	—	45	6	142	13	38	—	53	10	234	6	30	6
179	Dry Ground Manhaden Fish Guano,	256	—	157	6	—	—	45	10	56	6	154	—	—	—
195	Economical Manure,	297	3	52	—	108	6	56	13	7	10	172	13	173	10
207	High Grade Potato Manure,	185	13	39	13	—	—	—		—	—	—	—	—	—
209	Chittenden's Ammoniated Phosphate,	315	3	47	6	25	10	177	3	23	3	224	—	42	6
213	Vegetable and Vine Fertilizer,	223	13	39	6	90	—	32	13	9	3	132	—	253	10
216	Fish and Potash,	200	—	50	3	—	—	78	13	40	13	119	10	112	—
226	Dry Ground Fish,	216	—	150	13	—	—	87	—	78	—	165	—	—	—
230	Market Garden Fertilizer,	201	10	61	—	79	3	71	10	50	—	202	13	188	13
238-266	Potato, Hop and Tobacco Manure,	260	6	42	6	146	—	46	13	27	10	220	6	63	3
241	Potato and Tobacco Manure,	259	—	44	—	96	13	84	6	57	3	238	6	68	—
255	Peruvian Guano,	191	10	163	3	14	13	151	10	86	13	253	3	40	—
274	High Grade Fish and Potash,	249	—	63	10	—	—	179	3	51	3	230	6	93	10
277	Special Potato Fertilizer,	171	—	77	6	132	—	38	13	32	13	205	10	108	13
282	Wood Ashes,	277	—	—	—	—	—	—	—	—	—	33	3	108	13
	Bones.														
8-221	Bone Meal,	267	—	48	3	—	—	169	10	366	13	536	6	—	—
290	Ground Bone,	80	—	64	—	—	—	165	10	314	13	480	—	—	—

For trade values of fertilizing ingredients see previous Bulletins.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 35.

THE AGRICULTURAL VALUE OF BONE-MEAL.

DECEMBER, 1895.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1895.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, " Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles H. Johnson, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles S. Crocker, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
George A. Billings, B. Sc.,	*Assistant in Foods and Feeding.*
Charles A. King,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

The Agricultural Value of Bone-meal.

Reviewed by Charles Wellington, Ph. D.
Associate Chemist Mass. Agricultural College.

The purpose of this bulletin is to place before farmers the latest results of comparative experiments with Bone-meal and other phosphates, applied as fertilizers, on various soils for various crops.

In the succeeding pages are data established by Wagner[1] of Darmstadt, and Steffek and Maercker[2] of Halle, in Germany, and others. These are believed to offer sufficient proof of the following statements.

SUMMARY OF BULLETIN.

		Page.	Table.
1.	The superior value which has hitherto been accorded to undissolved Bone-meal as a fertilizer is due solely to the nitrogen which it contains.		
2.	Undissolved Bone-meal as a phosphate fertilizer is no more valuable than are the raw mineral phosphates.	6	
3.	Hereafter it must be classed with the latter, rather than with high grade phosphates containing available phosphoric acid.		
4.	As a phosphate fertilizer it yields no better results than mineral phosphates, whether tried alone or with superphosphate, on loams or sandy soils, on soils rich or very poor in phosphoric acid, whether with grains or with turnips, mustard, or other cruciferous plants; either in the first or in succeeding crops.	9 10 13	I II III
5.	The various kinds of Bone-meal show no essential difference in these results.	9	I
6.	The best form in which to apply Bone-meal is as "Dissolved Bone-meal," i. e. mixed with 60 degree sulfuric acid, at the rate of 20 per cent for raw, and 40 per cent for glue-free Bone meal.	16	VI
7.	For stocking land with a supply of phosphoric acid, "Dissolved Bone meal" is better adapted than is superphosphate.	18	

Special attention is directed to the short tables on pages 6, 9, 10, 12, 13, 17.

[1] All references may be found on page 18.

PHOSPHORIC ACID[3].

This element of plant food exists in the various manurial substances, combined either with water alone or with lime in one of four different proportions. Such combinations, their *approximate* relative solubility, and their occurrence, may be briefly described as follows :—

COMPOUNDS OF PHOSPHORIC ACID[3] AND LIME.

	Composition		*Name*	*Soluble in*	*Occurs in*
1	Lime Lime Lime	Phos. Acid	*Three-lime phosphate or bone-phosphate.*	Acid. Very slowly in soil waters.	*Bones, Mineral phosphates.*
	(i. e. 3 parts of lime with 1 part acid.)				
2	Lime Lime Water	Phos. Acid	*Two-lime phosphate or Reverted phosphate.*	Citrate of ammonia. Soil waters holding carbonic acid.	*Superphosphates, etc. "Dissolved bone-meals."*
	(i. e. 2 parts of lime to 1 part acid.)				
3	Lime Water Water	Phos. Acid	*One-lime phosphate or "soluble phosphate"*	Water	*Superphosphates.*
	(i. e. 1 part of lime to 1 part of acid.)				
4	Water Water Water	Phos. Acid	*Phosphoric acid.*	Water	*Certain very high grade phosphates.*
	(i. e. 3 parts of water to 1 part acid.)				
5	Lime Lime Lime Lime	Phos. Acid	*Four-lime phosphate*		*Phosphatic slag.*
	(i. e. 4 parts of lime to 1 part acid.)				

Superphosphates, dissolved bone-meals and other manufactured products may contain phosphoric acid in all of the first three forms.

It should be remembered that the above *parts* are not by weight, but by bulk. One part by bulk of lime weighs 56 pounds, one part by bulk of phosphoric acid[3] weighs 142 pounds.

Lime, lbs.	Phos. Acid, lbs.	Lbs.
168 combine with	142 to form	310 three-lime phosphate.
112 " "	142 " "	254 two-lime "
56 " "	142 " "	198 one-lime "

The less lime in combination the more soluble the phosphate. Consequently we find three-lime phosphate the least soluble and one-lime phosphate the most soluble of the first three compounds.

By mixing ground bone with enough (160 pounds of pure) sulfuric acid to combine with two parts (112 pounds) of lime, a bone-meal superphosphate is produced. Such a product has very undesirable physical properties. By mixing with enough (80 pounds of pure) sulfuric acid to combine with one part (56 pounds) of lime, a "dissolved bone-meal" is produced. See page 16.

HISTORICAL.

Bones are said to have been first employed to a large extent, as a fertilizer, in 1794. For some time they were applied without being treated in any manner. During the first three-fourths of this century they were composted with many kinds of material, especially with lime, ashes and animal refuse. In 1840, superphosphate was first made by Liebig, who accomplished this by "dissolving" bones with sulfuric acid. Shortly thereafter Sir John Lawes manufactured "superphosphate of lime" by this process. Bones were soon ground to "bone-meal." This method of treatment has been highly developed, so that now a large variety of products known by the general term of bone-meal are made. The varieties considered in this bulletin are raw bone-meal, produced by simple grinding, steamed bone-meal by steaming and grinding, and "glue-free" bone meal, obtained by grinding what remains after the glue has been removed from the bones by cooking. These are each further classified according to the fineness of their particles.

The fineness of a bone-meal is ascertained by passing the material through a series of sieves, with meshes of regularly decreasing size, and weighing the different siftings. An illustration of this process is found on page 8.

It has long been held that phosphoric acid in bones and bone-meal is in such form, as to be quickly available to plants, when applied to the soil.

Bone-meal has been considered profitable for application to light, sandy soils, especially to those low in phosphoric acid.

During the past decade many tests have been made by various experimenters, to determine the actual availability of this form of phosphoric acid, as compared with that in Apatite, South Carolina Phosphate, and other mineral phosphates, as well as superphosphates.

The following investigators have published reports on this work: Farrington[4]; Armsby and Caldwell[5]; P. Wagner[1]; Marek[6]; Holdefleiss[7]; Ulbricht[8]; Kellner and Japanese assistants[9]; Steffek and Maercker[2].

These experimenters obtained somewhat varying results. Armsby and Caldwell have carried on for over four years a valuable series of experiments.

They apparently show that on lime, peat and sandy soils phosphoric acid in bone-meal is profitably applied, and that on such soils the effect is inversely as the solubility of the phosphoric acid. This is a conclusion at variance with the opinion held by many, that *only quick acting manures* are profitable. A large part of the fertilizing effect of bone-meal must be ascribed to its nitrogen.

WAGNER'S (Darmstadt) RESULTS.

The publication by P. Wagner, of results obtained in 1889, first raised serious doubt as to the supposed superiority of bone-meal phosphate. They are summarized as follows:

1. *Rye-cultures sown with Clover.* 1889.

With phosphoric acid in superphosphate,	100	lbs. of crop
With same quantity in ground Thomas Slag,	59	“ “
With same quantity in bone-meal,	8	“ “

2. *Experiments on Clay Soil.*

First year:		
With phosphoric acid in superphosphate,	100	lbs. of crop
With same quantity in bone-meal,	5	“ “
Second year:		
With phosphoric acid in superphosphate,	100	“ “
With same quantity in bone-meal,	15	“ “
Third year:		
With phosphoric acid in superphosphate,	100	“ “
With same quantity in bone-meal,	17	“ “

These figures present a surprising result. The bone-meal in the first year shows in one case only 8 per cent, and another only 5 per cent of the effect of the superphosphate, but it is also far behind the superphosphate *in its after effect.*

STEFFEK & MAERCKER'S (Halle) EXPERIMENTS.

These include Series A to F; pages 6 to 18, and Tables I. to VI.

The Wagner experiments awakened solicitude among the bone-meal manufacturers and this, doubtless, was the reason why the "Bone-meal Manufacturers Association" of Saxony appealed to the Halle Experiment Station to test the question, and appropriated for this purpose a considerable sum.

Steffek & Maercker[2], for the Station, complied with the request and obtained, after four years, the results presented in the following pages. These proved a severe disappointment to the bone-meal manufacturers and also a surprise to the experimenters. They are, however, in accord with the statements of Wagner[1], and the experiments were executed with great care and deliberation.

All of these experiments were conducted in the Wagner "Vegetation pots." These are water-tight, upright cylinders, open at the top, made of sheet zinc, 7.9 inches in diameter and 7.9 inches high, standing on three legs 2.5 inches high (or of still other dimensions)[10].

Professor Wagner[10] has developed this method into a sharp analytic system, for determining accurately the relative field value of all manurial substances. It is simple enough for any one to carry out, and by no other method can equally good results be obtained.

The claim has been made that this mode of testing is not a fair one for the bone-meal, because the latter cannot act so effectively as in the open field. It has been repeatedly shown, however, that with *every other* kind of fertilizing material, results are obtained in the pots fully as favorable to the fertilizer, as those obtained in the field. Generally they are *more* favorable. There is no good reason for supposing the method to be prejudicial to the interests of bone-meal alone. No pains were spared to so arrange the tests as to get, if possible, favorable results from the bone-meals. Not in a single instance has such an end been reached.

Investigations with bone-meal, previous to the work at Halle, had been subject to criticism, because the materials employed did not represent the average bone-meals of the market. This objection cannot be raised in the present case, because these fertilizing materials were furnished by the Saxon Bone-meal Manufacturers Association, with the distinct statement that they were good average commercial articles. They are here described :—

VARIETIES OF BONE-MEAL USED IN THE HALLE EXPERIMENTS.

			PERCENTAGE ANALYSIS.	
NO.	BRAND.	FURNISHED BY	Phosphoric Acid.	Nitrogen.
1.	Untreated Raw Bone-meal.	H. Pahl in Koethen.	15.02	5.83
2.	Glue-free Bone-meal.		31.21	1.61
3.	Steamed Bone-meal.	The Hannover Artificial Fertilizer Factory, Linden (near Hannover).	22.77	4.92
4.	Mixed Bone-meal.	Beyerlein & Schmidt, Altenburg.	24.28	3.37
5.	Raw Bone-meal.	Eutritzsch Chemical Works (near Leipzig).	15.61	6.21
6.	Glue-free Bone-meal.		31.02	1.29

Sample No. 4 appears in trade, falsely, under the name “steamed bone-meal.” It is really a mixture of raw bone-meal and glue-free bone-meal. The relative fineness of these meals was as follows:

Size of Particles in millimeters[11].	1	2	3	4	5	6
Larger than 1 m.m.	0.4	—	—	4.0	6.4	—
“ “ 0.5 “	16.5	10.5	25.2	32.0	15.3	0.6
“ “ 0.2 “	13.0	9.5	12.5	6.4	5.0	2.6
“ “ 0.1 “	29.1	22.7	30.2	24.6	31.8	18.7
Smaller than 0.1 “	41.0	57.3	32.1	33.0	41.5	78.1
	100.0	100.0	100.0	100.0	100.0	100.0

Each of the pots contained 13.2 pounds of dry earth, resting on a layer of sand. The earth was kept in a uniformly moist condition, at the so called “optimum,” i. e., with from 60 to 70 per cent of the full amount of water present which the soil could hold. To every pot was added ten grams of carbonate of lime and three grams of a mixture of equal parts of chloride of potassium, sulfate of potash, and sulfate of magnesia. The nitrogen, necessary for the development of the plant, was given in the form of nitrate of ammonia. As bone-meals contain very different proportions of nitrogen, the pots having those richer in this element would have received more, for the same amount of phosphoric acid, than those with less nitrogen. These differences were cancelled by the addition of nitrogen in the form of horn-meal to all the pots, in the proportion requisite in each case. The pots which received no bone-meal, and those with superphosphate were supplied, of course, with their proper proportions of nitrogen in the form of horn-meal.

SERIES A. TABLE I. (1892.)

A sandy soil, low in phosphoric acid was used. These experiments were carried out with barley. After the barley, a second crop of pease, vetches and oats was raised, to ascertain the after-effect. For the purpose of control, each experiment was carried out in triplicate, i. e., in three different vegetation pots. Table I. shows the results which may be thus summarized :—

1. The effects of the phosphoric acid in the various bone-meals were not essentially different.
2. The effect of each of the bone-meals in the sandy soil, low in phosphoric acid, was extraordinarily slight. The following table shows this :—

Phos. Acid applied.		Amount of yield.	Phos. Acid in increase of yield.	Phos. Acid furnished to plant.		*After-effect.* Phos-Acid taken up by 2d crop
Amt.	Form.					
Grams.		Grams.	Grams.	Per cent.	Ratio.	Grams.
0.6	Superphos.	101.56	0.196	32.7	100	0.074
0.6	Bone-meal	5.96	0.009	1.5	4.6	0.032
1.5	Superphos.	114.38	0.378	25.2	100	0.110
1.5	Bone-meal	12.18	0.019	1.3	5.2	0.043

The yield of the second crop of pease, vetches and oats should show whether, according to general belief, the slowly acting phosphoric acid of bone-meal is taken up in any considerable quantity by the after-crop. If phosphoric acid in bone-meal can claim a high fertilizing value, and yet cannot show a result with the first crop equal to that of phosphoric acid in superphosphate, it must then yield superior results with the second and still later crops. The figures of the last column above prove that even this was not the case, for there was no higher yield as an after-effect of the phosphoric acid in bone-meal than of that in superphosphate, and the quantity of phosphoric acid, which the superphosphate could yield the plant, was far greater than that from the bone-meal. But it should be particularly emphasized that, even in the after effect, the bone-meals cannot make up for what they have failed to accomplish with the first crop.

SERIES B. TABLE II. (1893.)

In order to ascertain to what extent bone-meals are capable of adding to a store of easily soluble phosphoric acid, which shall be readily available to the plant, the following experiment was conducted in 1893. Vegetation pots were filled with a sand extremely low in phosphoric acid, and to this was given a supply of varying quantities of superphosphate, with which were mixed different amounts of phosphoric acid, in the form of bone-meal.

Although the bone-meal phosphoric acid did not become effective, this was not due to unfavorable conditions.

As the 1892 samples of bone-meal gave such poor results on soils low in phosphoric acid, new samples for the 1893 experiments were selected. These were numbers 5 and 6 of page 8.

In these experiments barley was grown on a sandy soil low in phosphoric acid. From the results, as found in Table II, the following conclusions are drawn :

1. The new samples of bone-meal act no more favorably than those used in the former experiments. See column a. in next table. The maximum yield, according to the above figures, was produced by the application of 1.2 grams of phosphoric acid per pot, but the increased yields, produced by the bone-meal phosphoric acid, are here again *extraordinarily low.*
2. The barley plants are not able to take up significant quantities of phosphoric acid from the bone-meal, although considerable quantities were taken up from the superphosphate. See column b.

Phos. Acid applied.		a.	b.
Amount.	Form.	Increase of yield. Grams.	Phos. Acid furnished to plant. Grams.
0.6	Superphos.	167.29	0.200
0.6	Raw meal	1.42	0.005
0.6	Glue-free	3.29	0.002
1.2	Superphos.	204.44	0.371
1.2	Raw meal	7.79	0.000
1.2	Glue-free	13.62	0.009
1.8	Superphos.	202.40	0.501
1.8	Raw meal	13.28	0.014
1.8	Glue-free	27.45	0.027

3. The same result was yielded by the experiments in which soluble phosphoric acid, reinforced with bone-meal, was used. The following are the figures obtained in these cases :—

a. Experiments with 0.3 gram of soluble phosphoric acid as chief fertilizer. This weight of superphosphate acid must have given, according to Table II, an increase of yield of 83.65 grams and furnished 0.100 gram of phosphoric acid to the barley.

Phos. Acid applied.		Increase of yield.	Increase of yield due to bone-meal.
Grams.	Form.	Grams.	Grams.
0.3	Superphos.	gave 86.66	3.01
0.3	Raw bone-meal		
0.3	Superphos.	gave 95.28	11.63
0.3	Glue-free bone-meal		
	Average	90.97	7.32

The 0.3 gram phosphoric acid should have produced an increase of yield of 83.65 grams, but the 0.3 gram of bone-meal phosphoric acid gave the diminutive increase of 7.32 grams.

While 0.3 gram of phosphoric acid, in superphosphate, could have yielded the plant 0.1 gram of phosphoric acid, the mixture of 0.3 gram in superphosphate and 0.3 gram in bone-meal yielded in one case, 0.12 gram, in another case, 0.088 gram of phosphoric acid. The barley, therefore, took up of the bone-meal phosphoric acid only the small average quantity of 0.01 gram, that is, practically nothing.

b. The experiments with larger amounts of bone-meal phosphoric acid yielded the same result. 0.3 gram in superphosphate and 0.9 gram of bone-meal phosphoric acid gave an average yield increase of 104.67, while the 0.3 gram in superphosphate, alone, increased the yield 83.65. The increase due, therefore, to the 0.9 gram of bone-meal phosphoric acid was 21.02 grams.

1.5 grams of bone meal phosphoric acid, with 0.3 gram in superphosphate but slightly raised the increase, that is to only 105.91 grams, so that for these 1.5 grams of bone-meal phosphoric acid only 22.26 grams of increase was due to the bone-meal phosphoric acid, against the 120.79 grams produced by an equal application of phosphoric acid in superphosphate. With application of 0.9 gram and 1.5 grams of bone-meal acid, 0.049 gram and 0.052 gram, respectively, were taken up. The same quantities of acid in superphosphate yielded the plants 0.286 and 0.317 gram respectively.

c. Precisely the same result was obtained when stronger applications were made of superphosphate as chief fertilizer.

While 0.6 gram of superphosphate acid with 0.6 gram of bone-meal acid gave a yield increase of 152.74 grams, 0.6 gram of superphosphate acid, alone, would have given an increase of 167.29 grams. Of the phosphoric acid in the bone-meal in this case, only 0.038 gram went into the plant, while of 0.6 gram of superphosphate acid 0.2 gram was taken up. When 0.6 gram in superphosphate and 1.2 grams of bone-meal acid were given, an increase of yield of 156.05 grams were obtained, so that here, also, the bone-meal phosphoric acid had produced no effect. Only 0.058 gram from the latter was taken up, while from 1.2 grams of superphosphate acid 0.371 gram was taken up. Finally, when 0.9 gram of superphosphate and 0.9 gram of bone-meal phosphoric acid were applied, there was an increased yield of 181.94 grams, whereas 0.9 gram of superphosphate acid would have given an increase of 187.87 grams. Here again the bone-meal phosphoric acid was quite ineffective. Of the bone-meal phosphoric acid applied, only 0.016 gram was taken up.

These figures show that with an application of mixed fertilizers containing superphosphate and bone-meal phosphoric acid, one may expect simply the yield increase due to the superphosphate, or, at most, only slightly more than that. Under these circumstances bone-meals do not appear to be profitable phosphoric acid fertilizers.

This disposes of the idea that an addition of phosphoric acid, in the form of bone meal, to a supply of available and effective phosphoric acid, works better than bone-meal phosphoric acid alone.

The question is of course not settled by one harvest, for there is a possibility that the after-effect of bone-meal phosphoric acid can make up for what it has neglected to do in the first year.

SERIES C. TABLE III. (1894.)

It might be thought that although with bone meal fertilization an intensive and quick effect could not be produced, yet a field, by its application, might be so enriched as to produce a profitable effect for a long time.

To test this question, oats and then mustard were raised in 1894, on the same soils, without a new application of phosphoric acid. The necessary amounts of nitrogen and potash were given. Results are shown in Table III and are thus summarized :—

1. The after-effect of the bone-meal application was as follows :

Phos. Acid applied. Grams.	INCREASE OF YIELD OF OATS. Grams.		
	With Superphos.	With Raw bone-meal.	With Glue-free bone-meal.
0.6	14.74	12.36	16.14
1.2	43.41	13.58	22.34
1.8	65.57	35.40	26.11

The smallest of these applications of superphosphate did not show any considerable after-effect. This can be easily understood, for in the first year it was relatively all taken up by the plants. Moreover, it is known that a part of the soluble phosphoric acid in the soil enters into less soluble forms.

The larger applications, however, showed a very satisfactory after-effect, which has far exceeded that of equal quantities of phosphoric acid in bone-meal. We therefore conclude : that the after-effect of bone-meal phosphoric acid, in the case of oats, was not greater, but very much less than that of the superphosphate, and further, the bone-meals by no means made up for what they had neglected to do in the first year.

The experiments in which mixtures of superphosphate and bone meal were applied gave the same result, as for instance :—

a. 1.2 grams phosphoric acid.

		Increase of yield. Grams.
As superphosphate	gave	43.41
In raw bone-meal	"	13.58
In glue-free bone-meal	"	22.34

Average yield increase due to *bone-meals*, 17.96

b. 0.6 gram of superphosphate acid with 0.6 gram of bone-meal acid gave an increase of yield of 24.94 grams. The average results of the experiments with raw and glue-free bone-meal are the same.

Subtracting from the 24.94 grams 14.74 grams, due to the after-effect of 0.6 gram of superphosphate acid, there remain 10.2 grams of increase of yield, due to the 0.6 gram of bone-meal acid, while from the superphosphate acid an after-effect of (43.41—14.74) 28.67 grams would be expected.

c. 0.3 gram of superphosphate acid with 0.9 gram of bone-meal acid gave an increase of yield of 19.8 grams. Subtracting from this 7.37 grams, due to the 0.3 gram of superphosphate acid, there remain 12.43 grams increase for the 0.9 gram of bone-meal acid. From a like quantity of superphosphate acid an increase of 36.04 grams would be expected.

d. Exactly the same is true of the largest application of phosphoric acid in which 1.8 grams, in the form of superphosphate acid, produced an increase of 65.03 grams.

We thus have produced by 0.3 gram of superphosphate acid with 1.5 grams of bone-meal acid an average yield increase of 23.62 grams. Deducting 7.37 grams, for the effect of the 0.3 gram of superphosphate acid, and 16.25 grams increase remain, for the effect of 1.5 grams bone-meal acid. The superphosphate acid would have given an increase of (65.03—7.37 grams) 57.66 grams.

0.6 gram of superphosphate acid with 1.2 grams of bone-meal acid gave an average increase of yield of 26.74 grams; from this subtracting 14.74 grams, the increase of yield due to 0.6 gram of superphosphate acid, and 12.00 grams remain for the 1.2 gram of bone-meal acid. But a like quantity of superphosphate acid would have produced (65.03—14.74 grams) 50.29 grams.

0.9 gram of superphosphate acid with 0.9 gram of bone-meal acid gave an increase of yield of 35.08 grams; taking from this 29.08, the amount due to 0.9 gram of superphosphate acid 6.01 grams remain for the bone-meal, while the same quantity of superphosphate acid would have given ($\frac{65.03}{2}$), 32.52 grams of increase of yield.

However the combination may be made, with much or little bone-meal, the effect is the same. No result can be produced, with oats as a second crop, which would not be approximately that of the superphosphate phosphoric acid alone.

In Table III are the figures for the after-crop of mustard i. e. the third crop. The oats were harvested in the beginning of August, the mustard, had no further application of phosphoric acid, but did receive nitrogen and gave the following results:

INCREASE OF YIELD OF GREEN MUSTARD.

Grams.

Phos. Acid applied. Grams.	Superphosphate.	Raw bone-meal.	Glue-free bone-meal.
0.6	52.9	—0.3	+34.2
1.2	173.9	—4.9	+15.2
1.8	196.9	+85.2	+33.9

With the third crop the bone-meal gave not even approximately the results of that with superphosphate.

The mixture of superphosphate and bone-meal phosphoric acid also produced as little, with a single exception, namely with the combination of 0.6 gram of phosphoric acid in superphosphate and 1.2 grams in raw bone-meal, which gave an exceptional result of 242.4 grams. Such a result was produced by no other combination, and we must conclude that other and peculiar circumstances were here in control.

It is now clear that for sandy soils, low in phosphoric acid, neither the bone-meal phosphoric acid alone nor in combination with superphosphate can produce an effect which even approaches the corresponding effect of the superphosphate acid; especially is this true if the relative prices are considered. In most cases the effects have been so low that they do not deserve consideration.

SERIES D. TABLE IV. (1894).

Bone-meal is generally considered a specific fertilizer for sandy, or at least light soils. In 1894 numerous experiments were made with this material on soils whose various amounts of phosphoric acid had been determined by previous experiments. These soils belong chiefly to the group known as loams, but among them were several sandy soils. In this way it could be ascertained whether bone-meal would do better in soils in which it were required to furnish only a part of the necessary phosphoric acid. Nitrogen and potash were applied in sufficient quantities. The results are given in Table IV, and are essentially the same as those of the experiments on sandy soils. The three averages for *increase of yield* were respectively:—

With	Grams.	With	Grams.
Superphosphate	118.98	glue-free bone-meal	6.91
	45.67	raw bone-meal	7.11
	75.33	steamed bone-meal	1.29
Average	79.99		5.10

It was here of no consequence whether the soil showed a large or a small amount of phosphoric acid, for in no single instance could the bone-meal phosphoric acid, applied in any form, show an effect worthy of note. In most cases the increase of yield was scarcely more than the limit allowed for error in such experiments. In every case the superphosphate produced most satisfactory results. That this could not be otherwise may be concluded from the figures showing the removal of phosphoric acid, that is the phosphoric acid in the increase of yield. These averages were:—

	Grams.		Grams.
With Superphos.	0.571	With glue-free bone-meal	0.034
	0.213	“ raw “	0.007
	0.301	“ steamed “	0.032
Average	0.362		0.024

Only 7 per cent of the superphosphate phosphoric acid taken up came from the bone-meal, the same quantities of phosphoric acid being applied in each case. This result is strikingly similar to Wagner's statement concerning the effectiveness of bone-meals in the first year, and also to the figures which were above given for sandy soils. Bone-meal, therefore, behaves in loam soils as it does in sandy soils, in soils rich in phosphoric acid as it does in those low in that acid. In each case the bone-meal phosphoric acid failed to produce any important effect.

SERIES E. TABLE V. (1894.)

To answer the question still more completely, mustard was raised as a second crop, after barley, to ascertain whether, in the various soils, an after-effect of the bone-meal phosphoric acid could be noticed. The number of these experiments is somewhat greater than those with barley, because several barley experiments were ruined by attacks of the corn-fly.

These, however, serve to show the after-effect, and the results are given in Table V. The increase of yield is shown as follows:

	Grams.		Grams.
With Superphos.	30.7	with glue-free bone-meal	2.7
	28.3	with raw “	5.2
	26.0	with steamed “	7.6
Average	28.3		5.2

In no single instance did the bone-meal phosphoric acid approximate in its effects that of the superphosphate. The same result appears from figures showing the removal of phosphoric acid by the crop.

	Phos. Acid, grams.		Phos. Acid, grams
With Superphos.	0.209	with glue-free bone-meal	0.003
	0.199	with raw “	0.016
	0.170	with steamed “	0.026
Average	0.193		0.015

The bone-meal phosphoric acid could accordingly produce only 7.7 per cent of the after-effect on plants which the superphosphate acid produced (7 per cent with the first crop).

SERIES F. TABLE VI. (1894).

These investigations would carry an unwelcome conclusion if it were not possible in some way to make the phosphoric acid in bone-meal more effective. The treatment, with sufficient sulfuric acid to produce superphosphate, would not help the bone-meal manufacturers greatly, for even then the phosphoric acid would not bring a better return than that contained in the raw mineral phosphates. Moreover bone-meal, as is well known, produces superphosphate of an undesirable physical character. Experiments were made to determine whether it might be possible to treat bone-meal with small quantities of sulfuric acid and still produce a product having approximately the effect of a superphosphate. See page 5. Bone-meal gives more promise with such a treatment than do the compact raw mineral phosphates, because the porous bone absorbs the acid like a sponge, and distributes it through its entire mass much more thoroughly. The last experiments were made with raw bone-meal and glue-free bone-meal, which had been treated with slightly more sulfuric acid than was required to produce two-lime phosphate. For this operation, fine, dusty meal was not used, but a meal of about the size of very small pease, which easily pulverized, so that the grinding was simplified by the operation. Allowance was made for lime carbonate. Sixty degree sulfuric acid was used, at the rate of twenty pounds per hundred for raw-bone meal, and forty pounds per hundred for glue-free bone-meal. The "dissolved bone-meals" had the following composition :—

Raw Bone-meal	12.88	per cent phosphoric acid.
of this	11.09	per cent soluble in citrate of ammonia.
	6.32	per cent " " water.
	4.93	per cent nitrogen.
Glue-free Bone-meal	21.81	per cent phosphoric acid.
of this	21.09	per cent soluble in citrate of ammonia.
	6.89	per cent " " water.
	0.89	per cent nitrogen.

The experiments with these preparations were carried on in sandy soils, low in phosphoric acid. in connection with the experiments with the different bone-meals in 1893, with barley, and in 1894 with oats and mustard. Table VI gives the results.

As could be seen upon examining the crushed particles of the raw bone-meal which were hard and glassy, the acid had not penetrated very far. On this account the full amount of the soluble phosphoric acid was not produced. The effect was however a considerable one, as the following shows :—

Form.	Phos. Acid applied. Grams.	Increase of yield of barley entire crop. Grams.	Phos. Acid in Increase of yield. Grams.
Dissolved raw bone-meal	0.6	128.71	0.128
	1.2	184.02	0.257
	1.8	200.65	0.367
Dissolved glue-free bone-meal.	0.6	160.29	0.196
	1.2	180.42	0.282
	1.8	207.50	0.470
Superphosphate	0.6	167.29	0.200
	1.2	204.44	0.371
	1.8	202.40	0.501

The dissolved glue-free bone-meal had been acted on by the sulfuric acid more uniformly. The yield, therefore, and the amount of phosphoric acid taken up by the plants approach, in the latter case, nearly the results with superphosphate.

In the second crop, oats, the dissolved raw bone-meal was also somewhat behind the soluble phosphoric acid, while the prepared glue-free bone-meal was quite equal to that standard.

	Phos. Acid applied. Grams.	Increase of yield of oats entire crop. Grams.	Phos. Acid in Increase of yield. Grams.
Dissolved raw bone-meal.	0.6	16.06	0.024
	1.2	30.67	0.060
	1.8	42.99	0.098
Dissolved glue-free bone-meal.	0.6	12.80	0.034
	1.2	40.13	0.119
	1.8	75.04	0.206
Superphosphate	0.6	14.74	0.027
	1.2	43.41	0.089
	1.8	65.03	0.266

On the third crop, mustard, the dissolved raw bone-meal showed much better and made up in part for the previous poorer record.

INCREASE OF YIELD OF MUSTARD.

Phos. Acid applied. Grams.	With Dissolved raw bone-meal.	With Dissolved glue-free bone-meal.	With Superphosphate.
	Grams.		
0 6	121.2	103.7	52.9
1.2	151.2	117.9	173.9
1.8	206.2	175.7	196.9

This gives further proof of what has often been shown, that in order to produce an active phosphoric acid from raw materials, it is not necessary to change all the phosphoric acid to the soluble form. These preparations contain of soluble acid, in 100 parts of total phosphoric acid, 49 parts in the dissolved raw bone-meal, and 32.6 parts in the dissolved glue-free bone-meal.

The experiments show, therefore, that by a small addition of sulfuric acid to bone-meal, fertilizers are produced which in their first effect stand very near the superphosphates, and under some circumstances equal them. In their after-effects they are very good, and, in the long run, better than the superphosphates. Such preparations are therefore better suited for stocking lands with phosphoric acid than are the superphosphates (i. e. soluble phosphoric acid preparations). Whether or not similar preparations may advantageously be made from raw mineral phosphates must be determined by experiments. Sulfuric acid acts upon them more slowly and, according to experience, an insufficient addition of sulphuric acid produces more one-lime phosphate and free phosphoric acid than with the bone-meals, while a large portion of the three-lime phosphate remains undecomposed.

This danger does not appear to be present in so great a degree with the bone meal, and very likely the future bone-meal industry may include the preparation of these varieties of half-products (dissolved bone-meals) with a high fertilizing value.

Vegetation experiments not yet complete, apparently show that these half-products act almost as well as superphosphate, the same amount of phosphoric acid being applied.

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2. Über die Phosphorsäure Wirkung der Knochenmehle, Press of Paul Parey, Berlin, 1895.

3. Phosphoric anhydride (P_2O_5) is here called phosphoric acid. This is in accord with most agricultural writers. For the same reason sulphuric anhydride, (SO_3) is called sulfuric acid.

4. New Hampshire Agricultural Report 1888.

5. Pennsylvania " " 1888 pp. 5–19, also
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6. Liebig's Preisschrift, Press of G. Schönfelds, Dresden, 1889.

7. Das Knochenmehl etc., etc., Press of Paul Parey, Berlin, 1890.

8. Jahresbericht d. a. c. Versuchsstation zu Dahme, Press of A. Mieck, Prenzlau, 1893.

9. Landwirthschaftliche Versuchsstationen, 1892 and 1894.

10. J. B. Lindsey in Experiment Station Record, Washington, D. C., Vol. VII, p. 80 and following.

11. One millimeter is very nearly four hundredths of one inch.

TABLE I.

1892. SERIES A; BARLEY, PEASE, VETCHES AND OATS. ON SANDY SOIL, LOW IN PHOSPHORIC ACID.

		Barley.							Increase due to fertilizer.		Pease & vetches & oats as 2d crop.			In the two crops.	
		Air-dry yield (grs).			Phosp. acid in										
Phos. acid (grams).	KIND OF FERTILIZER.	Straw.	Grain.	Total.	Straw (per cent).	Grain (per cent).	Straw and grain (grams).	Number of stalks.	Air-dry crops (grams).	Phosphoric acid (grams).	Air-dry crop (grams).	Phosphoric acid (grams).	Phosphoric acid (grams).	Phosphoric acid (grams).	Increase of phos. acid due to fertilizer (grams).
—	Without phosphoric acid	44.34	6.23	50 57	0.070	0.397	0.056	49	—	—	9.42	0.400	0.037	0 093	—
0.6	Superphosphate	96 31	56.02	152.33	0.038	0.384	0.252	109	**101.56**	**0.196**	16.30	0.690	0.111	0.363	0.270
0.6	Raw bone-meal	41.65	10.28	51.93	0.045	0.378	0.058	64	1.36	0.002	12.20	0.480	0.058	0.116	0.023
0.6	Glue-free bone-meal	46.37	11.06	57.43	0.058	0.339	0.065	69	6.86	0.009	14.47	0.429	0.062	0.127	0.034
0.6	Steamed bone-meal	44.47	14.48	58.95	0.051	0.326	0.074	61	8.38	0.018	17.82	0.442	0 079	0.153	0.060
0.6	Mixed bone-meal	42.69	15.12	57.81	0.032	0.314	0.062	67	7.24	0.006	19.90	0.403	0.080	0.142	0.049
1.5	Supherphosphate	100.05	64.90	164.95	0.077	0.550	0.434	126	114.38	0.378	19.80	0.742	0.147	0.581	0.488
1.5	Raw bone-meal	45.70	14.12	59.82	0.045	0.339	0.069	63	9.25	0.013	12.55	0.640	0.080	0.149	0.056
1.5	Glue-free bone-meal	50.82	20.34	71.16	0.026	0.320	0.078	78	20.59	0.022	17.90	0.450	0.081	0.159	0.066
1.5	Steamed bone-meal	50.32	18.98	69.30	0.045	0.320	0.084	71	18.73	0.028	18 35	0.448	0.082	0.166	0.073
1.5	Mixed bone-meal	45.22	15.51	60.73	0.045	0.320	0.070	65	10.16	0.014	17.92	0.422	0.076	0.146	0.053

TABLE II. SERIES B, 1895. FIRST YEAR, BARLEY. SANDY SOIL, LOW IN PHOSPHORIC ACID.

Phosp. acid (grams).	KIND OF FERTILIZER.	Phos. acid totals (grams).	Yield (grams).			Phos. acid per. ct.		Phos. acid (grams).			Increase (grams).	
			Straw.	Grain.	Straw and grain.	Straw.	Grain.	Straw.	Grain.	Straw and grain.	Yield.	Phos. acid.
—	Without phosphoric acid	—	12.12	0.06	12.18	0.005	(0.250)	0.001	0.001	0.002	—	—
0.6	Superphosphate,	0.6	115.72	63.75	179.47	0.021	0.278	0.024	0.177	0.202	**167.29**	**0.200**
0.6	Raw bone-meal	0.6	13.17	0.43	13.60	0.005	(0 250)	0 006	0.001	0.007	**1,42**	**0,005**
0.6	Glue-free bone-meal	0.6	14.58	0.89	15.47	0.015	0.250	0.002	0.002	0 004	**3,29**	**0,002**
0.3	Superphosphate	0.6	64.65	34.19	98.84	0.060	0.266	0.039	0.091	0.120	**86.66**	0.118
0.3	Raw bone-meal											
0.3	Superphosphate	0.6	75.45	32.01	107.46	0.010	0.250	0.008	0.080	0.088	**95,28**	0.086
0.3	Glue free bone-meal											
1,2	Superphosphate	1.2	129.40	87.22	216.62	0.042	0.365	0.054	0.318	0.373	**204.44**	**0,371**
1,2	Raw bone-meal	1.2	18.02	1.95	19.97	0.005	(0.250)	0.001	0.001	0.002	**7,79**	**0,000**
1,2	Glue-free bone-meal	1.2	23.11	2.69	25.80	0.020	0.250	0.005	0.007	0.011	**13,62**	**0,009**
0.6	Superphosphate	1.2	96.52	66.42	162.94	0.073	0.288	0.070	0.190	0.260	150.76	0.258
0.6	Raw bone-meal											
0.6	Superphosphate	1.2	96.81	70.08	166.89	0.007	0.298	0.075	0.209	0.216	154.71	0.214
0 6	Glue-free bone-meal											
0.3	Superphosphate	1.2	73.55	41.61	115.16	0.043	0.269	0.031	0.112	0.143	102.98	0.141
0.9	Raw bone-meal											
0 3	Superphosphate	1.2	73.28	45.25	118.53	0.047	0.284	9.034	0.121	0.155	106.35	0.153
0.9	Glue-free bone-meal											
1,8	Superphosphate	1.8	128 76	85.82	214.58	0.058	0.499	0.075	0.428	0.503	**202,40**	**0,501**
1,8	Raw bone-meal	1.8	21.67	3.79	25.46	0.032	0.250	0.007	0.009	0.016	**13,28**	**0,014**
1,8	Glue-free bone-meal	1.8	30.89	8.74	39.63	0.008	0.301	0.003	0.026	0.029	**27,45**	**0,027**
0.3	Superphosphate	1.8	73.46	42.00	115.46	0.051	0.237	0.037	0.100	0.137	103.28	0.135
1.5	Raw bone-meal											
0.3	Superphosphate	1.8	74.89	45.93	120.71	0.051	0.279	0.038	0.128	0.166	108.53	0.164
1.5	Glue-free bone-meal											
0.6	Superphosphate	1.8	101.47	67.59	169.06	0.047	0.318	0.048	0.215	0.263	156.88	0.261
1.2	Raw bone-meal											
0.6	Superphosphate	1.8	102.00	65.40	167.40	0.047	0.314	0.048	0.205	0.253	155.22	0.251
1.2	Glue-free bone-meal											
0.9	Superphosphate	1.8	118.49	82.04	200.53	0.041	0.326	0.049	0.268	0.317	188.35	0.315
0.9	Raw bone-meal											
0.9	Superphosphate	1.8	108.79	78.72	187.51	0.018	0.339	0.020	0.267	0.287	175.33	0.285
0.9	Glue-free bone-meal											

TABLE III. SERIES C; 1894. AFTER EFFECT OF BONE MEAL—OATS. SANDY SOIL, LOW IN PHOSPHORIC ACID.

	KIND OF FERTILIZER.	Phos. acid. Totals (grams).	Yield (grams).			Phosphoric acid.		Increase (grams).		Mustard as after crop yield. (grams).
			Straw.	Grain.	Total.	Per cent.	In the crop. (grams.)	Yield.	Phos. acid in crop.	
—	Without phosphoric acid	—	6.90	0.38	7.28	0.200	0.015	—	—	33.8
0.6	Superphosphate	0.6	15.00	7.02	22.02	0.192	0.042	**14.74**	0.027	86.7
0.6	Raw bone-meal	0.6	13.95	5.69	19.64	0.307	0.060	**12.32**	0.045	33.5
0.6	Glue-free bone-meal	0.6	15.80	7.62	23.42	0.301	0.071	**16.14**	0.056	68.0
0.3 0.3	Superphosphate Raw bone-meal	0.6	15.00	7.03	22.03	0.224	0.049	14.75	0.034	113.0
0.3 0.3	Superphosphate Glue-free bone-meal	0.6	16.35	7.12	23.47	0.147	0.035	16.19	0.020	21.9
1.2	Superphosphate	1.2	30.80	19.89	50.69	0.205	0.104	**43.41**	0.089	207.7
1.2	Raw bone-meal	1.2	14.40	6.46	20.86	0.358	0.075	**13.58**	0.060	28.9
1.2	Glue-free bone-meal	1.2	18.60	11.02	29.62	0.294	0.087	**22.34**	0.072	49.0
0.6 0.6	Superphosphate Raw bone-meal	1.2	20.60	13.19	33.79	0.224	0.076	26.51	0.061	153.7
0.6 0.6	Superphosphate Glue-free bone meal	1.2	20.25	10.39	30.64	0.243	0.075	23.36	0.060	25.8
0.3 0.9	Superphosphate Raw bone-meal	1.2	16.90	9.68	26.58	0.243	0.065	19.30	0.050	66.9
0.3 0.9	Superphosphate Glue-free bone-meal	1.2	17.80	9.78	27.58	0.275	0.076	20.30	0.061	25.2
1.8	Superphosphate	1.8	45.75	27.10	72.85	(0.386)	0.281	**65.03**	0.226	230.7
1.8	Raw bone meal	1.8	24.35	18.33	42.68	0.365	0.156	**35.40**	0.141	119.0
1.8	Glue-free bone-meal	1.8	21.15	12.24	33.39	0.352	0.118	**26.11**	0.103	67.7
0.3 1.5	Superphosphate Raw bone-meal	1.8	18.00	12.59	30.59	0.250	0.077	23.31	0.062	170.0
0.3 1.5	Superphosphate Glue-free bone-meal	1.8	19.28	11.96	31.21	0.301	0.094	23.93	0.079	57.7
0.6 1.2	Superphosphate Raw bone-meal	1.8	22.50	17.59	40.09	0.224	0.090	32.81	0.075	242.4
0.6 1.2	Superphosphate Glue-free bone-meal	1.8	19.10	8.90	28.00	0.275	0.077	20.72	0.062	45.4
0.9 0.9	Superphosphate Raw bone-meal	1.8	27.20	17.98	45.18	0.173	0.078	37.90	0.063	162.7
0.9 0.9	Superphosphate Glue-free bone-meal	1.8	24.50	15.04	39.54	0.224	0.088	32.26	0.073	59.7

TABLE IV.

1894. SERIES D; BARLEY ON SOILS CONTAINING VARIOUS AMOUNTS OF PHOSPHORIC ACID.

Location.	Kind of soil.	Phosphoric acid applied. (grams).		Yield of grain (grams).			Total yield (grams).			Phosphoric acid in crop.			Increase of yield entire crop (grams).		Increase of yield phos. acid (grams).	
				Without phos. acid.	Bone meal.	Superphosphate.	Without Phosph. acid.	Bone meal.	Superphosphate.	Without Phosph. acid.	Bone meal.	Superphosphate.	Bone meal.	Superphosphate.	Bone meal.	Superphosphate.
Trotha	Loam	Glue-free bone-meal	2.0	10.76	13.26	64.78	48.16	48.26	179.18	0.222	0.238	0.735	0.10	131.02	0.016	0.513
Dom. Wegeleben	Humus loam......		1.0	23.60	36.72	44.92	69.00	87.12	127.52	0.212	0.262	0.523	18.12	58.52	0.050	0.311
Rttgt. Wegeleben	Loam		2.0	17.92	24.80	65.56	56.52	63.00	172.16	0.217	0.255	0.981	6.48	115.64	0.038	0.764
Rttgt. Gröst	Clayey loam		1.0	7.56	14.00	36.24	26.66	31.90	138.64	0.068	0.097	0.541	5.24	111.98	0.029	0.473
Beuchlitz I	Sandy loam......		2.0	7.76	10.56	81.72	33.46	38.06	211.12	0.071	0.110	0.866	4.60	177.76	0.039	0.795
		AVERAGE		13.52	19.87	58.64	46.76	53.67	165.72	0.158	0.192	0.729	**6.91**	**118.98**	**0.034**	**0.571**
Delitz a. B.	Light loam	Raw bone-meal....	1.0	44.83	48.08	42.84	129.13	138.48	154.64	0.430	0.461	0.742	9.35	25.51	0.031	0.312
Grossjena	Best alluvial loam		2.0	45.59	49.46	53.22	111.59	125.66	147.32	0.422	0.442	0.557	14.07	35.73	0.020	0.135
Beuchlitz II	Lighter loess-loam		1.0	37.43	34.34	50.40	88.43	85.34	164.20	0.271	0.241	0.463	−3.09	75.77	−0.030	0.192
		AVERAGE		42.62	43.96	48.82	109.72	116.49	155.39	0.374	0.381	0.587	**6.77**	**45.67**	**0.007**	**0.213**
Kl. Scwhechten	Humus sand	Steamed bone-meal	2.0	47.46	44.58	59.89	148.16	146.18	173.19	0.502	0.542	0.642	−1.98	25.03	0.040	0.142
Lauchstädt ...	Diluvial loam		2.0	3.00	4.35	51.52	19.30	23.85	144.92	0.041	0.066	0.501	4.55	125.62	0.025	0.460
		AVERAGE		25.23	24.47	55.71	83.73	85.01	159.06	0.272	0.304	0.572	**1.29**	**75.33**	**0.032**	**0.301**

TABLE V.

SERIES E; 1894. MUSTARD AS AFTER-CROP FOLLOWING BARLEY, ON SOILS CONTAINING DIFFERENT AMOUNTS OF PHOSPHORIC ACID.

Location.	Kind of Soil.	Phosphoric acid applied. (grams).		Air-dry yield. (grams).			Phos. acid in the crop (grams).			Air-dried increase. (grams).		Phos. acid in increase of yield. (grs).	
				Without Phosph. acid.	Bone-meal.	Super-phosphate.	Without phos. acid.	Bone-meal.	Super-phosphate.	Bone-meal.	Super-phosphate.	Bone-meal.	Super-phosphate.
Pötnitz	Clay	Glue-free bone-meal	1.0	15.4	18.4	36.5	0.051	0.061	0.201	3.0	21.1	0.010	0.150
Trotha	Loam		2.0	6.6	10.0	26.2	0.021	0.024	0.178	3.4	19.6	0.003	0.157
Dom. Wegeleben	Humus loam		1.0	8.5	7.8	48.2	0.034	0.022	0.276	–0.7	39.7	-0.012	0.242
Rttgt. Wegeleben	Loam		2.0	7.2	6.8	69.5	0.018	0.018	0.410	–0.6	58.3	0.000	0.392
Rttgt. Gröst	Clayey loam		2.0	10.0	10.8	25.0	0.030	0.025	0.133	0.8	15.0	-0.005	0.108
Beuchlitz I	Sandy loam		2.0	10.5	20.5	40.8	0.023	0.047	0.230	10.0	30.3	0.024	0.207
		AVERAGE		9.7	12.4	41.0	0.030	0.033	0.238	2.7	30.7	**0.003**	**0.209**
Dehtz a. B.	Light loam	Raw bone-meal	1.0	31.8	26.7	53.2	0.147	0.123	0.329	–5.1	21.4	0.024	0.182
Grossjena	Best alluvial loam		2.0	53.1	53.6	63.5	0.266	0.259	0.351	0.5	10.4	-0.007	0.085
Beuchlitz II	Light loess loam		1.0	11.9	23.0	53.6	0.032	0.077	0.313	11.1	41.7	0.045	0.281
Uthleben	Clay		2.0	15.3	22.9	31.3	0.052	0.092	0.189	7.6	16.0	0.040	0.137
Eptingen	Loam		1.0	5.0	14.5	46.6	0.016	0.038	0.301	9.5	41.5	0.022	0.285
Trotha II	Heavy Loam		2.0	6.5	14.0	45.4	0.019	0.036	0.246	7.5	38.9	0.017	0.227
		AVERAGE		20.6	25.8	48.9	0.089	0.104	0.288	5.2	28.3	**0.024**	**0.199**
Schlanstedt	Humus clay	Steamed bone-meal	1.0	37.6	43.2	60.8	0.177	0.201	0.379	6.2	23.8	0.024	0.202
Kl. Schwechten I	Humus sand		1.0	27.8	38.6	45.1	0.140	0.199	0.257	10.8	17.3	0.050	0.117
Kl. Schwechten II	Sandy		2.0	9.3	11.9	45.8	0.020	0.034	0.264	2.6	36.5	0.014	0.244
Eptingen	Loam		1.0	5.0	5.9	30.6	0.012	0.015	0.197	0.9	25.6	0.003	0.185
Lauchstädt	Loam		2.0	9.8	27.3	36.5	0.032	0.072	0.134	17.5	26.7	0.040	0.102
		AVERAGE		17.9	25.4	43.8	0.076	0.104	0.246	7.6	26.0	**0.026**	**0.170**

TABLE VI.

SERIES F; 1894. DISSOLVED BONE MEALS WITH BARLEY, OATS AND MUSTARD ON SANDY SOILS, LOW IN PHOSPHORIC ACID.

	KIND OF FERTILIZER.	Phos. acid (grams).	Yield (grams).			Phos. acid in crop (grams).	Increase of yield (grams).	
			Straw.	Grain.	Total.		Yield.	Phosph. acid.
I. Crop, barley.	Diss. raw bone-meal……	0.6	91.58	49.31	140.89	0.130	128,71	0,128
	Diss. glue-free bone-meal..	1.2	116.85	79.35	196.20	0.259	184,02	0,257
	Diss. glue-free bone-meal..	1.8	124.90	87.93	212.83	0.369	200,65	0,367
	Diss. glue-free bone-meal..	0.6	112.54	59.93	172.47	0.198	160,29	0,196
	Diss. glue-free bone-meal..	1.2	121.38	71.22	192.60	0.284	180,42	0,282
	Diss. glue-free bone-meal..	1.8	132.78	86.70	219.48	0.472	207,30	0,470
	Superphosphate …………	0.6	115.72	63.75	179.47	0.202	167,29	0,200
	Superphosphate …………	1.2	129.40	87.22	216.62	0.373	204,44	0,371
	Superphosphate …………	1.8	128.76	85.82	214.58	0.503	202,40	0,501
II. Crop, oats.	Diss. raw bone-meal……	0.6	16.20	7.14	23.34	0.039	16,06	0,024
	Diss. raw bone-meal……	1.2	27.00	18.89	45.89	0.075	30,67	0,060
	Diss. raw bone-meal……	1.8	36.60	26.08	62.68	0.113	42,99	0,098
	Diss. glue-free bone-meal..	0.6	12.75	7.33	20.08	0.049	12,80	0,034
	Diss. glue-free bone-meal..	1.2	27.30	20.11	47.41	0.134	40,13	0,119
	Diss. glue-free bone-meal..	1.8	49.80	32.52	82.32	0.211	75,04	0,206
	Superphosphate …………	0.6	15.00	7.02	22.02	0.042	14,74	0,027
	Superphosphate …………	1.2	30.80	19.89	50.69	0.104	43,41	0,089
	Superphosphate …………	1.8	45.75	27.10	72.85	0.281	65,03	0,266
III. Crop, mustard.	Diss. raw bone-meal……	0.6	—	—	155.0	—	121,2	—
	Diss. raw bone-meal……	1.2	—	—	185.0	—	151,2	—
	Diss. raw bone-meal……	1.8	—	—	240.0	—	206,2	—
	Diss. glue-free bone-meal..	0.6	—	—	137.5	—	103,7	—
	Diss. glue-free bone-meal..	1.2	—	—	151.7	—	117,9	—
	Diss. glue-free bone-meal..	1.8	—	—	209.5	—	175,7	—
	Superphosphate …………	0.6	—	—	86.7	—	52,9	—
	Superphosphate …………	1.2	—	—	207.7	—	173,9	—
	Superphosphate …………	1.8	—	—	230.7	—	196,9	—
	Without phos. acid ………	-	—	—	33.8	—	—	—

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 36.

Imported Elm Leaf Beetle,
Maple Pseudococcus,
Abbot Sphinx,
San Josè Scale.

FEBRUARY, 1896.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1896.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are:—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles H. Jones, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
George A. Billings, B. Sc.,	*Assistant in Foods and Feeding.*
Charles A. King,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

Division of Entomology.

Robert A. Cooley.

THE IMPORTED ELM LEAF BEETLE.

Galerucella luteola (*Mull.*)

The elm leaf beetle is a native of Europe, but made its first appearance in this country about sixty years ago and, though it has long been present in the sea-board states south of us, it was not known to occur in Massachusetts till the summer of 1895. So far as is known the occurrence in this state is confined to the valley of the Connecticut river, apparently having been introduced along the lines of traffic from the state of Connecticut, where it has been present in destructive numbers for several years.

The American elm, *Ulmus americana*, is noticeably exempt from attack when the European elm, *Ulmus campestris*, is at hand. When the two stand side by side the latter may be seriously eaten and the former untouched. In the absence of the favorite species, however, the American elm is unhesitatingly attacked.

The insects pass the winter as perfect or adult beetles (Fig. 1, *c* and *k*.), in cracks of fences, piles of boards etc., as well as in houses, barns and other accessible places. They begin to appear the following spring, a little before the buds of the elm open and continue to come out for two or three weeks. The females lay their eggs in clusters of from five to twenty, on the under side of the young leaves and then die. The eggs are orange yellow in color and oblong-oval in shape, tapering toward one end, the opposite end being attached to the leaf, and the surface, when highly magnified, is seen to be reticulated with hexagonal figures (Fig. 1, *f*.). In about a week these eggs hatch and it is in the larval stage that the greater part of the feeding is done. The young larva is elongated

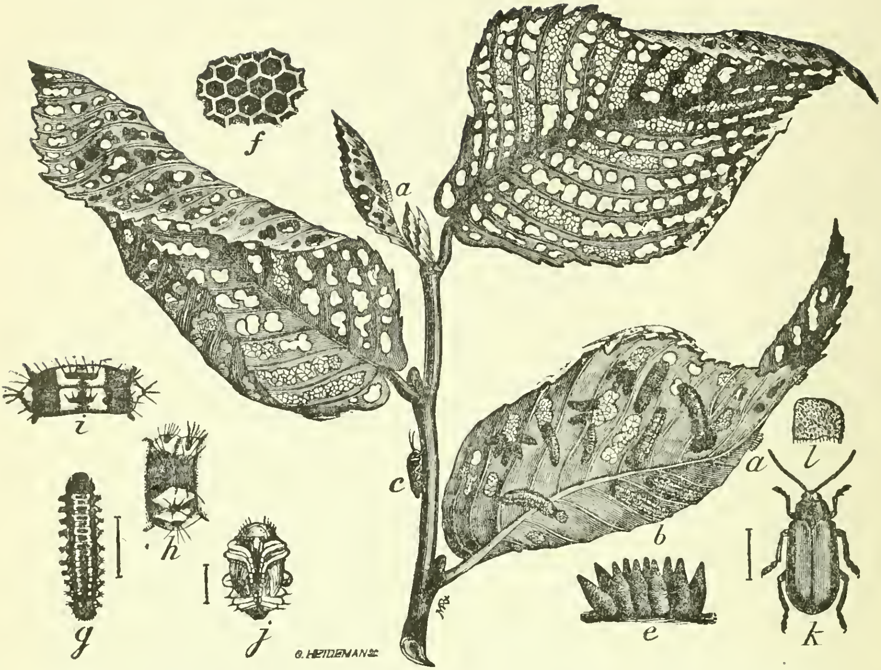

FIG. 1.—*Galerucella luteola*: *a*, eggs; *b*, larvae; *c*, adults; *e*, eggs (enlarged); *f*, sculpture of eggs; *g*, larva (enlarged); *h*, side view of greatly enlarged segment of larva; *i*, dorsal view of same; *j*, pupa (enlarged); *k*, beetle (enlarged); *l*, portion of elytron of beetle (greatly enlarged).—From Department of Agriculture.

fusiform, tapering from the head backward, yellowish black in general color, with large black markings from which arise long, stiff hairs. With each successive molt the black markings become proportionately smaller and the yellowish markings more pronounced. The mature larva has the body somewhat flattened and nearly equal in width throughout, the hairs becoming fewer in number, shorter and lighter in color. A full grown larva is about half an inch in length and has a wide dorsal stripe of yellow, with a lateral stripe of the same color on each side. The greater part of the head and legs and the posterior portion of the last segment of the body are black. In Fig. 1, *g*, a larva is shown enlarged, and on a leaf several are represented as feeding.

As soon as the young are hatched, they begin to feed, which they continue to do for about two weeks, but as the eggs do not all hatch at once, the larvae may be found on the trees for a much longer period of time. When the larvae have finished feeding they crawl down the trunk of the tree in search of a place to pupate. The ground at the base of the tree appears to be the normal place for pupation, though many transform in crevices of the bark before reaching the ground, while others drop from the limbs, especially when they bend down near the ground.

The pupa (Fig. 1, *j.*) is uniform light yellow, oval in shape, more rounded on the back than on the ventral side and is considerably shorter and broader than the full grown larva.

In from six to ten days the perfect beetles emerge, and, after feeding on the leaves for a short time, seek their winter quarters where they remain till the following spring. The perfect beetle averages about a quarter of an inch in length and is yellowish brown in color, with three more or less apparent longitudinal, blackish stripes on the back. Farther south there are two distinct broods of the insect each year, but in our latitude it is not probable that there is more than one, though a partial second brood may occur.

REMEDIAL MEASURES.

In fighting these insects we may follow two lines of operation according as they are few in number or abundant. Where there are but few it may be as well to watch for and kill the pupae at the base of the trees. This is of great importance since the larvae from a few beetles, if allowed to lay their eggs, will do much damage. The loose bark of the trunk and larger limbs should be scraped off, that as many of the insects as possible may descend to the ground, and then once in four or five days those which have collected should be killed. This may be done by hand, where they are only scattering, or by the application of some contact insecticide, as boiling water, or kerosene emulsion diluted four times. If individual tree owners would care for their trees in the manner outlined, a great deal might be done to check the advance of this pest. Where the insects are numerous, more active measures must be adopted. If anything like thorough work is desired, it is of great importance to kill the beetles themselves when they first appear on the trees in the spring.

In a paper by Mr. C. L. Marlatt, Assistant United States Entomologist, read before the meeting of the Association of Economic Entomologists held at Springfield last September, it is stated that an application of arsenate of lead, at the rate of one pound to about nine gallons of water, made as soon as the leaves began to develop, was effectual in killing the beetles. It was also stated that a previous application of the same poison may have aided the second application in the destruction of the beetles.

Arsenate of lead was used in preference to Paris green because it can be used in any desired strength without injury to the foliage. Arsenate of lead is a new insecticide and has not yet appeared in the market, but the Gypsy Moth Committee purchased it from the firm of Johnson & Shaw, India Wharf, Boston, in large quantities for nine cents a pound.

Next in importance to the killing of the beetles is the killing of the larvae, as they appear two or three weeks after the unfolding of the leaves. For this purpose Paris green, at the rate of one pound to 100 or 150 gallons of water, should be applied in a spray. Both sides of the leaves should be covered since the larvae feed on both surfaces, eating only the outer tissue. The beetles, on the contrary, devour the entire substance of the leaf. In spraying either with arsenate of lead or Paris green, small trees may be treated with an ordinary hand pump. For larger ones the same pump may be used aided by a piece of hose. One man climbs about in the trees applying the spray to the different limbs, while a man on the ground or in a wagon works the pump. Steam pumps will prove an advantage where spraying is to be done on a large scale and on large trees. The mixture should be kept well stirred to prevent settling. Any insects escaping the effects of the poison should be subjected to the treatment recommended for killing pupae. I should have added, however, that where the pest is abundant it will be necessary to treat the entire surface of the ground beneath the tree, since, as has been mentioned, a part of the insects drop directly to the ground, and to destroy these the ground should be thoroughly sprayed with kerosene emulsion diluted about four times.

Although Prof. Fernald has previously published the method of preparing kerosene emulsion we add it here. The substances required are water, two quarts; common bar soap, one fourth of a pound; kerosene four quarts. The water is heated to boiling, the soap being dissolved in it meantime, and while still very hot the kerosene is added and with a force pump the nozzle of which is directed back into the mixture, the whole is churned for about five minutes, or until it is emulsified (jelly-like when cold). If well prepared this emulsion may be kept for a long time or it may be used at once. For ordinary spraying on foliage it should be diluted with nine parts of water, but for the elm leaf beetle it should be diluted only four times.

If a soap powder could be used in place of bar soap, which dissolves very slowly, time would be saved in making kerosene emulsion, especially where spraying is done on a large scale. In this way the emulsion could be made in the spraying tank, the boiling water being poured in, the soap powder and kerosene oil added and the churning done and it would then be ready for diluting.

To determine if this could be done, experiments were performed in making emulsion, using various soap powders in place of bar soap, but it was found that even with six times as much of the powder, by weight, as of bar soap, the emulsion could not be satisfactorily prepared.

THE MAPLE PSEUDOCOCCUS.

Pseudococcus aceris (Geoff.).

The first account of this insect in the United States was given by Miss Emily A. Smith in "The North American Entomologist" for April, 1890, in which she records its occurrence in Peoria, Ill., on sugar maple. Although thus far it has been found only on maple in this country, it occurs in Europe on elm, linden and chestnut as well as on maple. It has been authentically reported in this country only in Massachusetts, Rhode Island and Illinois. In Massachusetts it has been found more or less abundantly in Jamaica Plain, Brookline, Norwood, Everett, Malden, Melrose and Somerville, and also in some localities in the Connecticut river valley.

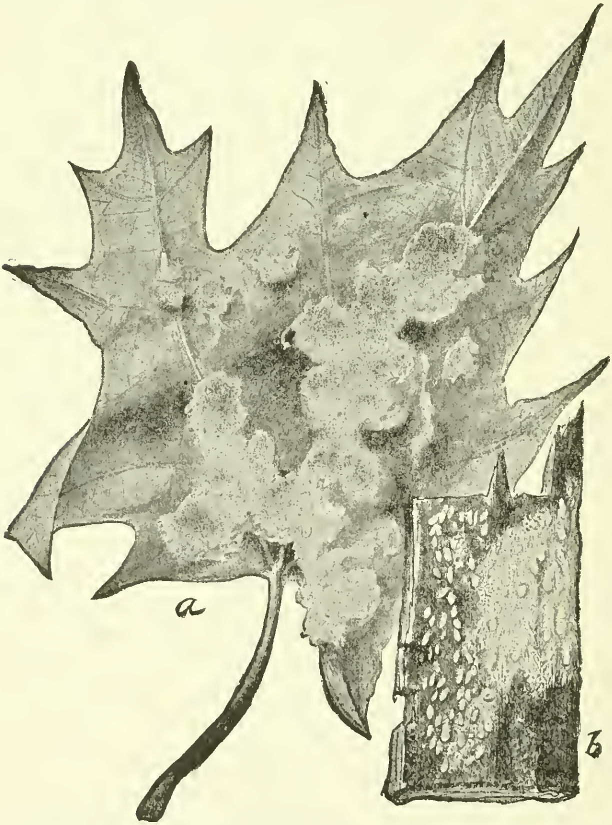

FIG. 2.—*Pseudococcus aceris: a,* adult females on leaf; *b,* young female and males on bark—natural size.—From Insect Life.

This insect is generally observed in summer when it appears as a dirty white, woolly and powdery mass, more or less oval in shape and about one-fourth of an inch in length (Fig 2, *a.*) At one end of the mass, which consists of waxy threads secreted from the back of the insect, together with about five hundred eggs, is the shriveled body of the female. These eggs are light yellow in color, a little less than half a millimeter in length and about half as wide.

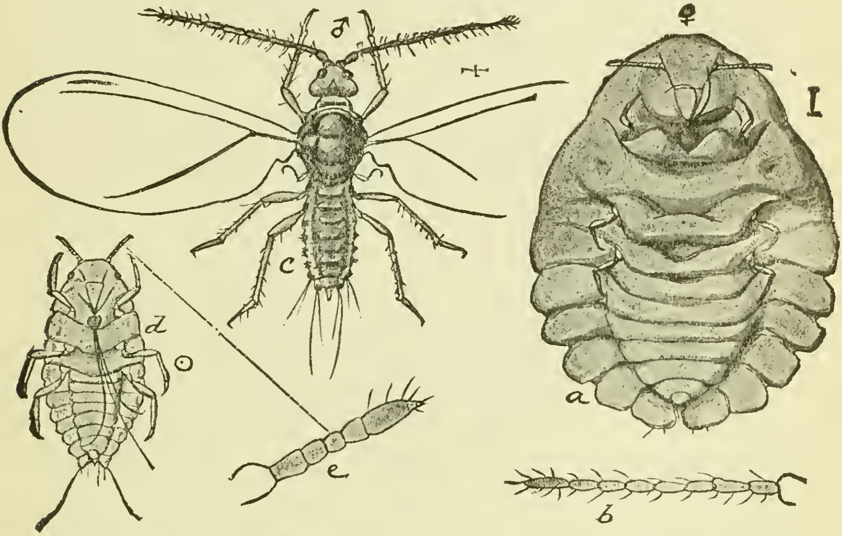

FIG. 3.—*Pseudococcus aceris: a*, adult female; *b*, antenna of same; *c*, adult male; *d*, young larva; *e*, antenna of same—*a, c, d*, greatly enlarged; *b, e*, still more enlarged. —From Insect Life.

The young females are pale yellow and the males red. The female is long and oval in form, slightly tapering toward either end. The antennae (Fig. 3, *e*) which are six-jointed have the last joint the longest and about equal in length to the three preceding combined. The second joint is slightly longer than the third, fourth or fifth. In front of the antennae the head bears several slender hairs. The eyes are dark purplish, and in front of each is a single short spine. The prothorax has three similar spines, while all of the remaining segments except the last have one each. The anal lobes have two or three spines and one long slender bristle. The adult male (Fig. 3, *c.*) and the male larva are yellowish red.

When the young larvae are hatched they spread over the leaves and by means of the sucking proboscis or mouth parts, with which they are equipped, extract the juices. The males cease to feed about three weeks before the females are mature, and, after wandering about on the limbs and trunk for a few days, come to rest and spin slight cocoons in crevices of the bark where they transform to winged adults. In about three weeks the perfect males emerge, mate with the females, which have by this time become mature and are crawling about over the trunk and larger limbs. The female from this time on grows rapidly and after coming to rest secretes the waxy threads and lays her eggs. According to Miss Smith's observations there are three broods in a year.

The larvae which hatch from the eggs of the third generation pass the winter in the crevices of the bark of the trees and appear again the next spring. After completing their growth they lay the eggs for the next generation.

Unless the insects are very numerous the damage is but slight. They sometimes become so abundant, however, as to threaten the health of the trees. During the summer of 1895, the writer saw trees from which a portion of the leaves had fallen prematurely while those remaining looked yellow, giving the tree a sickly appearance.

REMEDIES.

A strong solution of whale-oil soap, applied either with a brush or as a strong spray, in the late fall or early spring, will prove effectual in killing the hibernating females and thus prevent another brood. Before applying the above solution the loose bark should be scraped from the trees.

THE ABBOT SPHINX.

Thyreus abbotii (Swains.).

The Abbot Sphinx is given a place in this bulletin, not because it is particularly destructive, but because it is frequently received at the Station with letters of inquiry about it. The principal food-plants of the larvae are grape and woodbine, and as these are often grown about buildings, the insect is easily detected. Its peculiar appearance excites curiosity and therefore it is frequently sent to us.

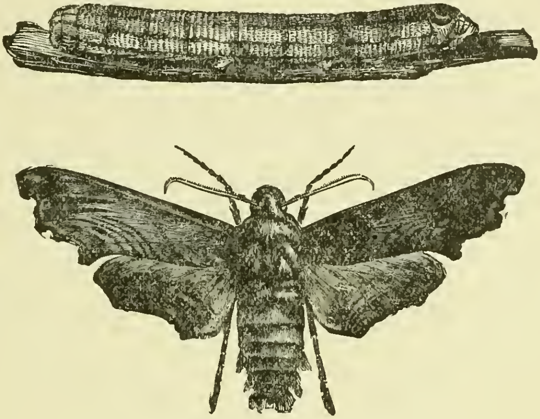

Fig. 4.—Thyreus abbotii, larva and imago.

This insect is distributed over the northern and eastern parts of the United States and is also found in Canada. It passes the winter as a pupa, at or near the surface of the ground. From these pupae the moths emerge during the month of May, in this State. One of these moths is represented in the lower part of Fig. 4.

They have an expanse of wings of about two and one-half inches. The head and thorax are dull chocolate-brown in color, the latter having two transverse blackish lines. The abdomen is dark chocolate-brown, lighter at the middle, with prominent tufts of hair at the end. The fore wings and the outer part of the hind wings are dull chocolate-brown, the base of the hind wings being yellow. The under side of the insect is much lighter in color.

The female moth lays her eggs during May and the larvae hatching from them, feed upon the leaves of the food plants, molting or casting their skins from time to time as they grow larger. They reach full size from the first to the middle of August, when they are a little over two inches in length. They vary in color from dull yellow to reddish brown, each segment bearing about six indistinct, transverse black lines, and are marked longitudinally with dark brown stripes. In the younger stages, there is a long, slender caudal horn, blackish in color, yellow at the base, but the mature larva has simply a black tubercle surrounded by a yellow ring. The mature larva is represented in the upper part of Fig. 4.

It is an interesting fact that, while the majority of the larvae of this species answer to the foregoing description, others occur with quite different markings. These have a row of large yellowish green spots on the back and a row of similar, but smaller spots on each side.

The larva having completed its growth crawls to the ground and constructs for itself a cell in which it transforms to a pupa and in this state it passes the winter. It is not probable that this insect will ever become so abundant as to require any remedy other than hand picking. A small Hymenopterous parasite preys upon the larvae and doubtless does much towards holding them in check. The parasite deposits its eggs on the victim and the young hatching from them, bore into the body and feed there until matured, eventually killing the host.

The following paper prepared by Professor Fernald, and published in the Massachusetts Crop Report for August, 1895, is reprinted here for the purpose of extending its distribution.

THE SAN JOSÉ SCALE.

Aspidiotus perniciosus Comst.

HISTORY AND DISTRIBUTION.

The San José (Sän Hō-sā′) scale insect first made its appearance in California not far from 1870, but it is not known from what country it came, though it is now known to occur in Chili, Australia and Hawaii. It increased rapidly till 1873, when it had become so abundant on the fruit trees at San José as to seriously injure them, and received the common name of the San José scale.

It was first technically named and described from Santa Clara County, California, by Prof. J. H. Comstock, in the report of the Department of Agriculture for the year 1880, page 304, under the name *Aspidiotus perniciosus*, "The Pernicious Scale." After describing it, Professor Comstock says: "From what I have seen of it, I think that it is the most pernicious scale insect known in this country; certainly I never saw another species so abundant as this one is in certain orchards which I have visited. It is said to infest all the deciduous fruits grown in California, excepting the peach, apricot and the black tartarian cherry. It attacks the bark of the trunk and limbs as well as the leaves and fruit. I have seen many plum and apple trees upon which all the fruit was so badly infested that it was unmarketable." Since Professor Comstock wrote the above, the insect has been found on apricot and peach as well as other plants.

In 1882 it had extended into all the fruit-growing districts of California and has since that time been distributed over the country more or less widely, and is now known to occur in Oregon, Washington, British Columbia, Idaho, Nevada, Arizona, New Mexico, Missouri, Indiana, Florida, Virginia, Maryland, Pennsylvania, New Jersey, New York and Massachusetts. It does not appear to be very generally distributed as yet in the Eastern States, but there is great danger that it may soon become so through the distribution of infested nursery stock, if the most active measures are not adopted for its destruction.

The dissemination of this insect in the Eastern States has been traced by the entomologist of the Department of Agriculture in

Washington to nursery stock received from Missouri and New Jersey. Prof. J. B. Smith, in "Entomological News," Vol. 6, page 153, and elsewhere, mentions two large nurseries in New Jersey that were badly infested with this scale, and from which infested stock had been sent to various points in the Eastern States. One of these was owned by Messrs. Parry, at Parry, Burlington County, N. J., the other by the J. T. Lovett Company, at Little Silver, Monmouth County, N. J.

Prof. L. O. Howard, entomologist to the Department of Agriculture in Washington, in studying the geographical distribution of this and other insects in connection with the life zones into which this country has been divided, has expressed the opinion that the San José scale is not likely to thrive on fruit trees in New England, for a time at least. Professor Smith seemed to entertain the same opinion, based on his studies of the distribution of the insect in New Jersey. I had therefore felt quite easy about the matter, so far as Massachusetts was concerned, till, on the 29th of March of the present year, my attention was called to some scale insects on several young plum trees on the grounds of the horticultural department of the Massachusetts Agricultural College. These trees, according to the record books, came from the J. T. Lovett Company, Little Silver, N. J., in the spring of 1894. Fearing that we had this dreaded insect to deal with, I sent infested twigs to Professor Howard for determination, and received the reply that they were the San José scale, but that none of the examples sent were alive.

Wishing to determine whether any of these insects had survived the winter, I had two of the trees taken up and set out in the cold part of the insectary greenhouse, and the remaining infested trees were burned. Scales appeared on the growth of the previous year, so that the insects succeeded well at least during the summer of 1894. June 10th live scales were observed on the trees transplanted to the insectary greenhouse, and on the 14th the young were swarming all over them, and even extended to some small apple trees growing near in the same part of the greenhouse. As this seemed to settle the question of their ability to survive our winters here in Amherst, or at least the winter of 1894—95, which was an average one, I had all these trees very carefully burned, to prevent any further spread of the pest.

As soon as it was discovered that the San José scale had been received here on nursery stock from outside of the State, I feared that other nurseries might have become infested in a similar manner, and therefore I sent my assistant, Mr. Lounsbury, to different nurseries to look for them. He reported that on April 19 he found the San José scale on two plum trees, two pear trees and a rose bush in Roslindale, Mass. The plum trees were badly infested with living scales, while the pear trees and rose bush were but slightly so. The scales occurred on all parts of the trees, but were the least numerous on the new growth. The pear trees had been on the grounds for three years and the plum trees two years. Mr. Lounsbury was informed that these trees were obtained from a local agent in West Roxbury, who claimed to have purchased them from the Shady Hill nursery, Bedford, Mass. On April 23 Mr. Lounsbury visited the Shady Hill nursery, and found the San José scale alive in large numbers on several different varieties of apple trees. Mr. Kohler, in charge of the nursery, told him that these trees were brought from the Cambridge nurseries, where they had been growing three or four years. The Cambridge nursery was then visited, and pear, peach and apple trees were found infested with the scale, and many of the worst-infested trees were dead. As no stock had been added to this nursery for three years, these trees must have been infested at least that length of time. I have not been able to learn from what source the stock in this Cambridge nursery was obtained.

On July 9 I received a twig of an apple tree from Mr. W. W. Rawson, with the request to inform him what the matter was with it. An examination showed that it was infested with the San José scale. Further correspondence revealed the fact that the twig came from an apple tree in the orchard of Mr. E. E. Cole, in the town of Scituate. Mr. Cole wrote me that the orchard contained ninety trees that were set out three years ago. It is situated in a protected spot with trees on three sides, and is within two miles of the ocean in a direct line. He also wrote me that the trees were received from Mr. Rawson, who informed me that he obtained most of his nursery stock of that description from the Shady Hill Nursery Company.

It is therefore probable that the Shady Hill nurseries received infested stock from some outside nursery, possibly in New Jersey, and have unintentionally become a centre of infection for orchards in the eastern part of this State. To what extent this pest has become distributed through the State it is impossible to say, but that it is able to live and destroy fruit trees in some, if not in all, parts of the State seems evident from this history, which is given here quite at length because of the expressed opinion of Messrs. Howard and Smith that it would not survive in New England.

DESCRIPTION OF THE SCALE AND INSECT *

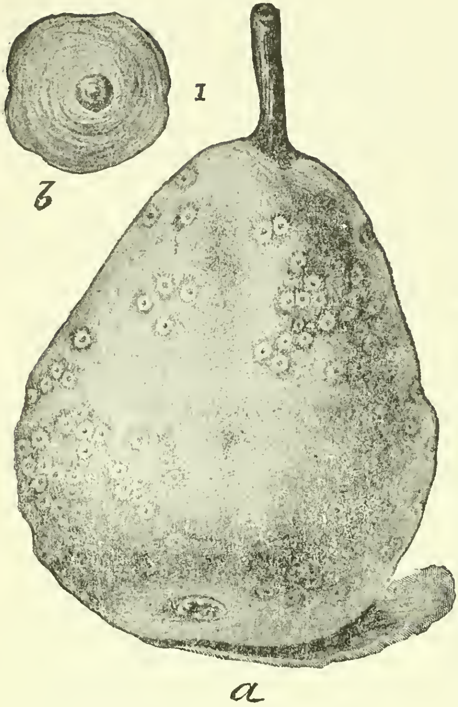

FIG. 5.—*a*, San José scales on a pear; *b*, a female scale enlarged.—From Department of Agriculture.

The female scale is shown in Fig. 5, *a*, of the natural size, on a moderately infested pear, and at *b*. greatly enlarged. It is quite flat, nearly circular in outline, about one-sixteenth of an inch in diameter, and dark, mottled with gray, in color, with a small elevated spot at or near the centre, which is black or yellowish.

The male scale is "black, somewhat elongated when fully formed. The larval skin is covered with secretions; its position is marked by a single nipple-like prominence, which is between the centre and the anterior margin of the scale. The scale of the male is more abundant than that of the female. It is often oval in shape and smaller in size than the female."

When these scales occur in large numbers on the twigs (Fig. 6) or leaves they frequently overlap, and are not easily distinguished without a magnifying glass. The general appearance which they give is of a greenish, very slightly roughened scurvy deposit. The natural color of the limbs of the peach and apple is quite obscured when these trees are thickly infested, and they then have the appearance of being coated with lime or ashes. When the scales are crushed a yellowish liquid appears, resulting from the crushing of the soft, yellow insect beneath, which indicates the existence of living scales on the trees.

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*The cuts used to illustrate this paper are from the United States Department of Agriculture, through the kindness of Prof. L. O. Howard.

These scales are often found on the fruit (Fig. 5), and when present in large numbers they prevent the full development of the fruit, causing it to crack or fall from the tree, or render it unsalable.

The mature male is very small, and supplied with two well-developed wings. It is shown greatly enlarged in Fig. 7, the natural size being indicated by the crossed lines in the small circle below the right wing.

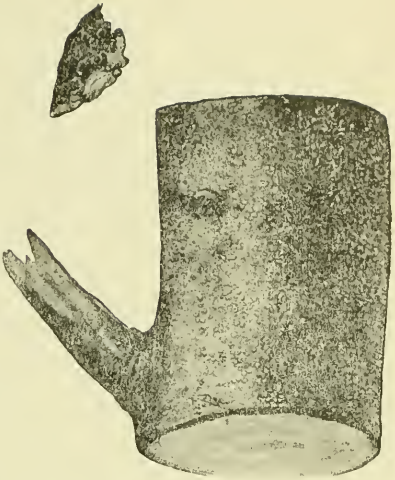

FIG. 6.—San Josè scales of natural size on an apple branch; scales somewhat enlarged on apple bark to the left above.—From Department of Agriculture.

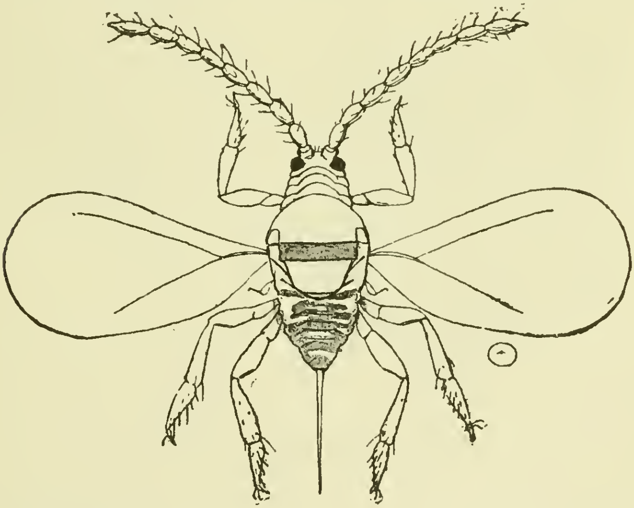

FIG. 7.—Male insect of the San José scale, greatly enlarged.—From Department of Agriculture.

Early in June, in this State, the young crawl out from beneath the scale and spread over the trees. They appear like moving points of yellowish color, and it is very difficult to distinguish them with the unaided eye. Fig. 8 represents the insect at this stage of its existence very much enlarged, with its three pairs of legs and one pair of antennae (one of which is still more enlarged at *b*), while its long, hair-like beak or proboscis, used for feeding, is shown curled up between its legs.

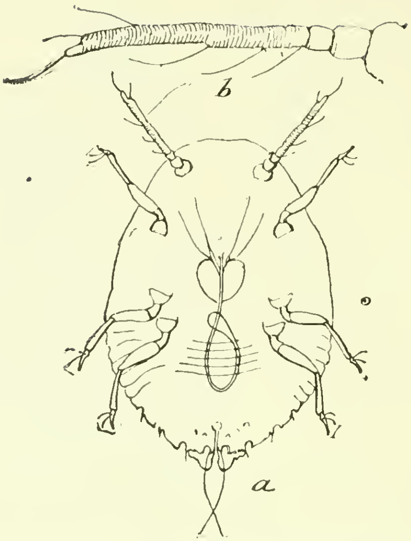

FIG. 8.—*a*, young larva of San José scale insect, under side, greatly enlarged; *b*, antenna still more enlarged.—From Department of Agriculture.

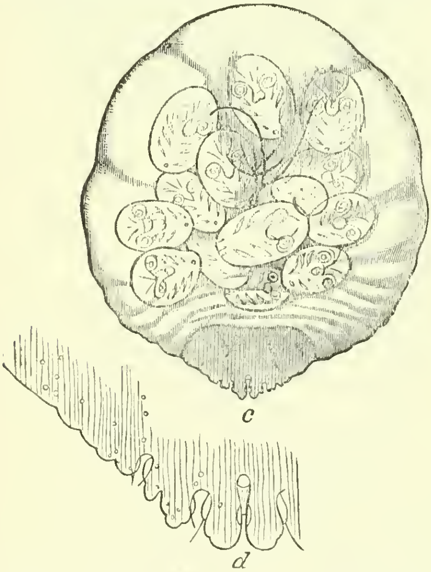

FIG. 9.—*c*, An enlarged view of an adult female of the San José scale insect, containing young; *d*, a portion of its anal fringe still more enlarged. —From Department of Agriculture.

The mature female, represented greatly enlarged in Fig. 9, is only to be seen by removing her from beneath the scale at the proper stage of development. When the young as described above has reached a satisfactory place of abode in its wanderings, it forces its sharp beak or proboscis into the bark and draws in the sap of the tree, and begins to form its scale. It grows and soon molts its skin, at which time it loses its legs and antennae, and takes the form represented in Fig. 9. Several broods of this insect occur in a season, the exact number of which is still in doubt, but possibly as many as five.

FOOD PLANTS.

The list of food plants of the San José scale insect, so far as known, are as follows: apple, pear, peach, plum, cherry, apricot, quince, flowering quince, almond, spiraæ, raspberry, rose, hawthorn, cotoneaster, gooseberry, currant, flowering currant, persimmon, elm, osage orange, linden, euonymus, acacia, English walnut, pecan nut, alder, weeping willow and laurel-leaf willow.

METHODS OF DISTRIBUTION.

As the mature female is wingless, and fixed to the tree on which she feeds, she will not be likely to cause other regions to become infested unless the tree to which she is attached is removed. Her progeny, however, when they are moving about freely, may be transported to places more or less distant by other insects, birds, larger animals or even by man; but the chances are not favorable for any very wide dispersion in this way. They may, however, be carried from one tree to another at no great distance. Infested fruit may be transported from one part of the country to another, and by chance be left in some place where it is possible for the young to crawl to some suitable food plant; but by far the most favorable method for the wide distribution of this insect is on nursery stock, and to this the most careful attention should be given.

It will be decidedly to the advantage of every dealer in nursery stock to take measures to clean his trees from this scale and to keep them free, for, if this be not attended to, purchasers will find other and more satisfactory parties to deal with.

REMEDIES.

If only a comparatively few small trees are infested in a nursery or orchard, the best way is to burn them, taking great care that in doing so none are scattered. There is no method of destroying insects equal to cremation.

Professor Howard, after having a long series of experiments performed for the purpose of ascertaining the best and most economical method of destroying this insect, says: "The only perfect results that have been reached have come from the application of two pounds or more of commercial fish-oil or whale-oil soap to a gallon of water soon after the leaves fall in the autumn, and from the application of a resin wash of six times the normal summer strength. The effects following the application of these washes leave nothing to be desired. In all cases the most careful search over the sprayed trees has failed to show a living scale." These are known as "winter washes," since they can only be used during the winter without serious injury to the trees. The winter resin wash mentioned above is composed of resin, one hundred and twenty pounds; caustic soda, thirty pounds; fish oil, fifteen pints; water sufficient to make one hundred gallons. The resin and soda are broken up and placed in a large kettle with the oil and sufficient water to cover them; the whole is then boiled for several hours, or until the compound will properly mix in water without breaking up into yellowish flakes. Experiments thus far made with applications during the summer have failed to give a substance that will destroy all of the insects. As good results have been obtained from the use of ordinary kerosene emulsion as from any other substance. It was found advisable, however, to repeat the spraying at intervals of about a week, as the young are brought forth in succession during the season.

LEGISLATION.

It is strongly recommended by some entomologists to have laws passed requiring nurserymen and other dealers to guarantee their stock free from the San José scale; but I am free to confess that I feel very doubtful about this matter. It seems to me that the fear of loss of trade will be a greater incentive to send out only uninfested stock than the fear of any amount of legislation.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 37.

REPORT ON FRUITS, INSECTICIDES, FUNGICIDES.

MARCH, 1896.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE.
1896.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
George A. Billings, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Charles E. Tisdale,	*Assistant in Foods and Feeding.*
Charles A. King,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

Summary of the Work

—OF THE—

HORTICULTURAL DIVISION FOR 1895.

S. T. MAYNARD AND J. H. PUTNAM.

EXPERIMENTS WITH APPLES.

Number of Varieties tested, 148.

The season of 1895 was the bearing year for most of the varieties in this section and the bloom was unusually large, but the late frosts, the severe drouth, at several times during the season, the unusual abundance of insects and fungi, and finally the severe hail storm of Sept. 11 rendered the crop, especially of the late varieties, almost a total failure. Up to this time the crop promised to be abundant and where the trees were sprayed of good quality.

All the trees in the station orchard except those omitted for checks, were sprayed according to the scheme proposed in the Spraying Calendar in Bulletin No. 29 of May, 1895, the results of which are illustrated in an experiment with five R. I. Greenings. The trees were 18 years old, of a vigorous growth and produced a heavy crop of apples. They were sprayed as follows:

Nos. 1, 2, 4 and 5, Apr. 10, Bordeaux mixture
" 1, 2, 4 and 5, May 8, " " and Paris green 1 lb. to 100 gals.
" 1, 2, 4 and 5, " 22, " " " " " "
" 1, 2, 4 and 5, June 8, " " " " " "
" 1 and 2, July 23, " "
" 1 and 2, Aug. 8, Ammoniacal Carb. of Copper.
" 3, was left unsprayed.

The following table shows the results:

VARIETY.	SPRAYING.	Picked Fruit.	Windfalls.	Per cent Wormy.	Per cent Scabby.
No. 1, R. I. Greening,	Sprayed 6 times,	8½ bu.	3½ bu.	6	2
No. 2, "	Sprayed 6 times,	13½ "	4½ "	7	5
No. 3, "	Not sprayed,	2 "	4½ "	55	100
No. 4, "	Sprayed 4 times,	7 "	5¼ "	20	15
No. 5, "	Sprayed 4 times,	8 "	1 "	12	20

All through the season the foliage of the sprayed trees was of a darker green color, was very much less injured by leaf-eating insects and fungi and was longer retained than that of the unsprayed trees. The fruit was examined critically at picking for quality and freedom from insect or fungous attack.

The work of spraying was largely done with a power pump by which the cost was reduced to the minimum. The beneficial results of spraying have been shown upon other varieties and upon other trees in the orchard but there being only a few trees of a kind the opportunity for comparison was not so good. The results however in the Station orchard and in many commercial orchards of the state, make it certain that we cannot be sure of good fruit without the proper use of insecticides and fungicides.

New Varieties.

Most of the 148 varieties of apples grown in the Station orchard are new and untried and although many have fruited they have not been tested long enough to prove their value for general cultivation. Among the most promising are the following:

Titkova. This is a large, early, striped Russian apple, not extremely early but its size is good, and it is colored sufficiently to be attractive before any of the older sorts are in the market. It is of fair quality and is especially good for cooking. It comes into bearing early and seems to be a hardy and productive variety.

Wealthy. Fall apples are not generally found so profitable in our markets as the winter varieties, but this apple, beautifully colored, of perfect form, fine flavor and good keeping quality, will if it proves hardy and productive, be profitable and we would advise apple growers to investigate its merits for home use and early shipping.

Pewaukee. This is a late keeping red apple of fairly good quality and has proved remarkably vigorous and productive. Many of our older varieties have, within a few years shown serious weakness and it is probable that they will not increase in vigor or productiveness, but rather deteriorate,and it is the part of good business forethought to be casting about for new varieties that shall take the place of those that fail to give profitable results. Among the many varieties attracting attention and which every grower should investigate, are the Ben Davis, Sutton Beauty, Palmer Greening, Mackintosh Red and Wolf River. It is a very difficult matter to determine the exact value of any variety until it has been extensively planted under varying conditions, but its behavior and value may be much more quickly determined if systematic report be made by all the growers who may have tested it. It is hoped that during the coming season something may be done toward collecting data concerning the merits of the different varieties in all sections of the state.

EXPERIMENTS WITH PEARS.

Number of Varieties Tested, 64.

The trees of the station orchard bloomed very full and until the middle of June promised a large crop of fruit, when the trees were attacked by the fire blight. The little insect known as the pear tree Psylla also appeared in great numbers at about the same time completely checking growth,and the crop was finally almost ruined by the hail storm of Sept. 11th, so that hardly a bushel of marketable fruit was obtained from a crop of a hundred bushels or more.

The appearance of the fire blight in such destructive force and for which no remedy has been found may perhaps be accounted for by the late growth of the trees during the autumn of 1894, after the unprecedented drouth of July and August of that summer. All branches attacked were cut off and destroyed as soon as possible, in many cases so many were cut away as to seriously disfigure the trees.

EXPERIMENTS WITH PEACHES.

Number of Varieties Tested, 42.

A large per cent of the peach buds was destroyed during the cold weather of the winter of 1894–5, but enough remained uninjured to give a good crop and the fruit set well, some of the early varieties being secured in good condition, but the hail storm so injured the later varieties that no comparison could be made.

WINTER KILLING OF PEACH BUDS.

The following table represents the per cent of buds found killed in every one hundred examined at intervals during the winter.

VARIETIES.	1895 Dec. 23	Dec. 30	1896 Jan. 8	Jan. 15	Jan. 22	Jan. 29
	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT
Amsden, - - - - -	3	5	10	60	75	100
Chapman, - - - - - -		5	3	80	90	100
Coolidge Favorite, - -			3	45	60	100
Crawford Early, - - -		5	5	80	90	100
Crosby, - - - - - -			12	70	70	100
Early Rivers, - - - - -			10	90	100	100
Early Victor, - - - -	10	10	40	65	100	100
Hales Early, - - - - -			8	45	65	100
Japan No 9, - - - - -	5	5	5	50	100	100
Lovett White, - - - - -	10	15	15	85	90	100
Mountain Rose, - - - -		4	12	58	58	100
Oldmixon, - - - - - -		2	15	60	85	100
Red Cheek Melocaton, - -	10	10	16	70	85	100
Reeves Favorite, - - - -	5	8	15	90	100	100
Russian, - - - - - -		3	5	80	90	100
Schumaker, - - - - -			6	90	100	100
Stump, - - - - - -	15	15	23	80	85	100
Wager Seedling, - - - - -			8	30	65	100
Waterloo, - - - - -	8	10	8	85	95	100
Wheatland Seedling, - -			18	45	60	100
Wonderful, - - - - -	20	20	15	69	65	100

The majority of buds were destroyed by the severe cold of Jan. 6th, 7th and 8th when the mercury registered at the meteorological department, 12°, 5.5° and 4.5° below zero although this injury did not become fully apparent until the last of the month. In seasons past and in the earlier part of this one some of the varieties have escaped total destruction of the buds, but this winter all varieties have finally suffered alike and not a living bud can be found at this date.

EXPERIMENTS WITH PLUMS.

Number of Varieties Tested, 42.

Although generally this fruit is a failure with most growers on account of the injury to the trees by the Black Knot and the plum curculio the trees in the station orchards have steadily improved and borne regular crops for many years.

Japanese Varieties.

No new fruit has attracted so much attention as the varieties of Japanese plums. They are found very vigorous in growth and come into bearing in three to five years from planting and many predict large profits from their cultivation. It is however too soon to determine how hardy they may prove, whether they will be subject to the Black Knot, the brown rot or some disease similar to the yellows on the peach, or whether they will be so popular in the markets as to demand a large supply. Some of the varieties have fruited in the Station orchard, e. g. the Georgeson, Abundance,Kelsey and Satsuma and the quality of these is such as to warrant us in reporting that they are at least promising. The Kelsey is the best in quality, but the tree proves tender and cannot be depended on at the north. One branch on an Abundance tree developed a premature ripening of the fruit, indicating some injury by the cold during the previous winter, other than this it seems perfectly hardy, is very productive and of good quality. Below we mention a few varieties that have attracted especial attention.

Georgeson (Hattonkio No. 1). Ripened Aug. 10, elongated, medium size, very good quality. Color, greenish yellow with light bloom. Not quite hardy.

Abundance. Ripened middle of August, medium size, red with yellow on shaded side. Very productive and appears hardy.

Satsuma and *Willard* fruited to a limited extent, but not sufficiently to warrant conclusion as to their merits.

Native Varieties.

Prairie Flower. Red. Ripened Aug. 12, clingstone, vigorous and productive, promising.

Wild Goose. The past season seemed peculiarly favorable to the perfection of this old variety. It produced a fair crop of fruit of medium size and fair quality. The fruit fell from the trees when about half colored and in two or three days turned to a bright red color with light bloom. Clingstone. They were marketed from one tree from July 16th to Aug. 24th, and on account of their earliness, even size and form, brilliant color, and fresh appearance found a quick sale in our local market.

Pottawattamie. Medium size, light red, falls before ripe. Poor quality, clingstone, productive and vigorous.

DESTROYING THE BLACK KNOT.

The results of spraying for the destruction of the Black Knot or wart, are shown in the following tables :

VARIETIES.		NUMBER OF KNOTS FOUND.			
		1892.	1893.	1894.	1895.
Washington,	Sprayed,	0	5	2	0
Lombard,		22	8	7	0
Washington,	Not sprayed,	6	20	8	7
Lombard.		22	10	10	5
Washington,	Sprayed,	5	10	3	0
Lombard,		66	27	10	1
Washington,	Not sprayed,	9	15	10	*0
Lombard,		13	19	4	*1
Lombard,	Sprayed,	1	3	0	0
		144	117	54	14
AVERAGE NUMBER OF KNOTS PER TREE.					
Sprayed,		18.8	10.4	4.5	.3
Not sprayed,		12.5	16.0	8.0	6.0

*Sprayed 1895.

The trees were sprayed with copper sulphate solution, Bordeaux mixture and ammoniacal carbonate of copper. The knots were painted with kerosene and mineral pigment during the summer, and removed during the early part of winter. When found on small twigs the knot and branch were removed, but when found on large limbs or strong shoots the knots were sliced off and the wound painted with lead and oil. This treatment has been given to sprayed and unsprayed trees alike. By studying the above table, which shows the results of the treatment on a row of Washington and Lombard trees we find :

1st. That the total number of knots has been steadily decreasing.

2d. That the average number on the unsprayed trees has decreased to one half the number in 1891, while on sprayed trees it has decreased to $\frac{1}{52}$ of the number found four years ago, or where one knot has been destroyed by painting and cutting, twenty-six have been destroyed by combining this treatment with spraying.

In Dec., 1895, 88 plum trees, of bearing size including many varieties were examined and the knots removed. These trees, with the exception of two Wild Goose, one Pottawattamie and three Japanese varieties, are all European plums. The young orchards containing the Japanese and native plums, having never been attacked with knot, are not included.

The results of the examination were as follows: On 78 sprayed trees were found 39 knots. An average of one knot to each two trees. On 10 unsprayed trees were found 52 knots. An average of 5.2 knots per tree. Thus the total number of knots found in the station orchards in 1895 was 91. In 1891 there were found on one Bradshaw tree 78 knots or nearly as many as were found in the entire orchard, in 1895 and twice as many as were found on all the sprayed trees in 1895. The tree above mentioned has been treated as described above and sprayed, and at the present time is entirely free from knots. Of the 78 sprayed trees 50 were found free from knots. Of the 10 unsprayed trees one, a Wild Goose, was found free from knots.

Summary.

1. By painting the plum knots with kerosene during the summer and removing from the tree and burning early in the winter before the winter spores are scattered, the disease can be held in check.
2. By combining the above treatment with proper spraying, the disease can be in large measure prevented and practically eradicated from orchards that have suffered from a severe attack.

Results of Spraying for Season of 1895.

The plums were sprayed April 5th with Bordeaux mixture.

May 3, Bordeaux mixture and Paris green 1 lb. to 100 gals.

May 20, “ “ “ “ “ “ “

June 6, “ “ “ “ “ “ “

Aug. 8, with Ammoniacal Carbonate of Copper.

On sprayed trees the fruit rotted much less than on unsprayed trees, but was not wholly free from rot.

On sprayed trees the curculio did much less damage than on the unsprayed ones. After all the fruit stung by the curculio was picked off a good crop remained.

On some unsprayed trees the curculio ruined the crop.

On the Washington plum trees, spraying had the most beneficial effect.

On the Lombard plums the effect was good, at least twice as much fruit maturing on sprayed trees as upon those unsprayed.

EXPERIMENTS WITH GRAPES.

Number of Varieties Tested, 145.

The experiment vineyard contains one hundred and forty-five named varieties of grapes. About thirty of these have not fruited sufficiently to determine their value and are not included in the table. There is also a collection of thirty seedlings, descendants from seedlings of the late Mr. E. W. Bull of Concord, Mass., received from Mr. A. B. Howard, Belchertown, Mass., and eight hundred seedlings raised on the station grounds from mixed seed. The vines are trained on the one arm renewal system, the trellis consisting of two wires, the upper carrying the fruiting cane and the lower the new cane for the next years fruiting. The vine is allowed to remain on the trellis through the winter without protection and nearly all of the varieties tested proved hardy enough to winter well under these conditions. In most cases two vines of each variety have been planted one of them being treated with insecticides and fungicides while the other was left untreated. The results fully demonstrate that, except in rare instances, by giving careful attention to spraying, we can grow to perfection many varieties that are very susceptible to mildew and rot, and that by protecting the vines from these diseases some otherwise tender varieties have gained in vigor and hardiness.

In the following tables the endeavor has been made to give in as concise a form as possible, the most important characteristics of the different varieties, as grown in the experiment vineyard. The tables represent the consolidation and average of results recorded during the last four years. The classification given is according to the Bushberg catalogue.

To test the keeping quality of the grapes they were put into a cold storage room in trays, examined carefully every two weeks, and their condition recorded. The average of these records for four years is here given. The dates of blooming and the dates of ripening vary from year to year, but as those given in this table are the average for five years they can be considered as fairly reliable for this locality. In determining quality their value for table use has alone been considered.

EXPLANATION OF TABLE.

Species. labr. for labrusca; rip. for riparia; Æst. for Æstivalis; vin. for vinifera; Hyb. for Hybrids; x crosses.

Size of bunch and berry. l., large; m., medium; s., small. For all other qualities 10 is nearest perfection.

GRAPES.

Black Varieties.

VARIETY.	SPECIES.	Date of Blooming.	Date of Ripening.	Hardiness.	Resistance to Disease.	Quality.	Size of Bunch.	Size of Berry.	Adhesiveness.	Keeping Qual.
Ann,		June 15	Sept. 25	10	7	6	m	m	8	5
Armenia, R. No. 39,	Labr.-hybr.	" 16	" 12	9	9	7	l	l	9	8
August Giant,	Rip.-hybr.	" 17	" 23	10	2	4	l	l	9	5
Bacchus,	Rip.	" 9	" 18	9	9	5	m	s	10	9
Black Eagle,	Labr.-hybr.	" 17	" 10	10	9	8	m	l	10	5
Canada, Ar. No. 16,	Rip.-hybr.	" 15	" 22	8	7	5	s	s	9	4
Caywoods No. 50,	(?)	" 13	" 10	10	9	6	m	m	7	2
Champion,	Labr.	" 10	Aug. 27	10	9	3	m	m	8	2
Clinton,	Rip.	" 7	Sept. 21	9	10	6	m	s	10	7
Concord,	Labr.	" 18	" 16	10	9	7	l	m	8	4
Cornucopia,	Rip.-hybr.	" 11	" 18	7	9	5	s	m	8	5
Cottage,	Labr.	" 16	" 13	10	9	5	m	m	7	2
Creveling,	Labr.-hybr.	" 15	" 10	10	10	4	m	m	9	2
Cynthiana,	Æst.	" 18	" 28	9	9	3	s	m	8	5
Eaton,	Labr.	" 16	" 25	10	9	7	m	l	10	3
Early Victor,	Labr. x,	" 11	Aug. 29	10	9	5	m	s	8	3
Elsinburg,	Æst.	" 21	Sept. 21	8	9	5	m	s	9	6
Excelsior,	Labr.-hybr.	" 23	Oct. 10	6	8	9	l	m	9	3
Hartford,	Labr.	" 11	Aug. 27	10	9	4	m	m	8	2
Herbert R. No. 44,	Labr.-hybr.	" 16	Sept. 13	9	7	10	l	l	10	10
Highland,	Labr.-hybr.	" 17	Oct. 10	10	9	7	l	l	9	9
Ideal,	Æst. x,	" 17	Sept. 12	7	9	9	m	m	7	7
Janesville,	Labr.	" 7	Aug. 28	10	8	3	m	m	8	3
Jewel,	Æst. x,	" 13	Sept. 2	9	9	10	s	s	9	8
Merrimac R. No. 19,	Labr.-hybr.	" 16	" 20	8	9	8	l	l	10	10
Mills,	Labr.-hybr.	" 23	Oct. 2	7	5	8	l	m	10	9
Montifore,	Rip. x,	" 13	Sept. 13	9	10	5	l	s	8	5
Moore's Early,	Labr.	" 12	" 2	10	10	7	m	l	7	2
Nectar,	Labr.-hybr.	" 18	" 19	9	10	9	m	s	10	7
Norman,		" 15	" 16	7	9	6	m	m	8	5
Norton's,	Æst.	" 20	" 23	8	10	5	l	s	9	5
Othello,	Rip.-hybr.	"	" 27	8	5	4	l	m	10	7
Peabody,	Rip. x,	" 17	" 2	8	10	9	l	m	9	5
Pizarro,	Rip.-hybr.	" 15	" 15	9	10	4	m	s	6	4
Rockwood,	Labr.	" 19	" 6	9	10	8	m	m	7	8
Rogers No. 32,	Labr.-hybr.	" 18	" 17	9	6	7	m	m	9	6
Rogers No. 33,	Labr.-hybr.	" 15	" 14	8	9	9	l	l	9	8
Rogers No. 34,	Labr.-hybr.	" 19	" 16	9	7	8	l	l	10	10
Secretary,	Rip.-hybr.	" 14	" 29	7	9	6	l	m	10	10
Seedling 15,	(?)	" 20	" 17	10	9	7	m	m	7	6
Seedling 18,	(?)	" 18	" 13	7	9	6	m	s	9	9
Standard,	(?)	" 14	" 21	10	9	8	l	m	9	8
Telegraph,	Labr.	" 10	" 28	10	10	3	m	m	7	3
Union Village,	Labr.	" 18	" 13	10	9	6	m	l	8	8
Wilder R. No. 4,	Labr.-hybr.	" 16	" 16	7	8	9	l	l	10	10
Worden,	Labr.	" 15	" 10	9	9	9	l	l	8	2

RED VARIETIES.

VARIETY.	SPECIES.	Date of Blooming.	Date of Ripening.	Hardiness.	Resistance to Disease.	Quality.	Size of Bunch.	Size of Berry.	Adhesiveness.	Keeping Qual.
Agawam R. No. 15	Labr.-hybr.	June 16	Sept. 17	9	6	9	l	l	9	7
Amber Queen,	Labr.-hybr.	" 15	" 24	10	6	7	m	s	6	2
Berckman,	Rip.-hybr.	" 14	" 15	9	8	9	m	s	9	9
Brighton,	Labr. x vin.	" 20	" 18	10	7	9	l	l	10	9
Catawba,	Labr.	" 23	Oct. 20	10	8	9	l	m	10	9
Centennial	Æst. x labr.	" 17	Sept. 20	9	9	9	l	s	9	8
Charter Oak,	Labr.	" 18	" 22	10	10	3	m	vl	4	3
Delaware,	?	" 13	" 7	9	7	10	m	s	8	7
Delaware Muscat,	?	" 17	" 16	8	9	4	m	s	8	5
Diana,	Labr.	" 19	" 13	7	9	7	m	m	9	7
Essex R. No. 41,	Labr.-hybr.	" 19	" 17	9	9	9	l	m	9	9
Goethe R. No. 1,	Labr.-hybr.	" 16	Oct. 5	10	7	8	l	l	9	10
Iona,	Labr.	" 22	" 3	8	9	10	m	m	9	8
Jefferson,	Labr. x	" 20	Sept. 28	10	8	9	m	m	9	9
Lee's Prolific,	Labr.	" 8	" 20	10	9	7	m	m	7	5
Lindley R. No. 9,	Labr.-hybr.	" 18	" 15	9	5	9	l	m	10	10
Massasoit R. No. 3,	Labr.-hybr.	" 17	" 18	9	5	8	l	l	9	9
Moyer,	Æst.-hybr.	" 10	" 2	8	7	9	m	s	6	3
Norfolk,	Labr.-hybr.	" 18	" 18	10	2	7	l	m	7	5
Northern Muscat,	Labr.	" 17	" 30	9	9	3	m	l	8	4
Oneida,	Labr.-hybr.	" 19	" 17	10	2	9	l	l	9	9
Oriental,	Labr.-hybr.	" 19	" 25	9	10	9	m	m	10	8
Perkins.	Labr.	" 13	" 20	9	10	5	m	m	4	3
Poughkeepsie,	Labr.-hybr.	" 18	" 11	10	7	10	m	m	8	5
Requa R. No. 28,	Labr.-hybr.	" 17	" 15	9	6	8	l	m	9	10
Rochester,	Labr. x	" 15	" 20	10	8	9	l	s	4	5
Rogers No. 30,	Labr.-hybr.	" 18	" 11	9	8	5	s	m	6	7
Salem R. No. 53,	Labr.-hybr.	" 17	" 16	9	4	9	l	l	9	9
Seedling No. 19,	?	" 20	" 29	10	9	5	m	m	2	2
Ulster,	Labr. x	" 12	" 27	8	8	9	m	m	7	9
Vergennes,	Labr.	" 17	" 20	10	4	9	l	l	10	10
Walter,	Æst. x labr.	" 15	Oct. 15	8	9	8	s	m	8	7
Woodruff Red,	Labr.	" 14	Sept. 27	10	9	6	m	l	5	7
Wyoming Red,	Labr.	" 15	" 7	10	8	8	m	m	5	7

WHITE VARIETIES.

VARIETY.	SPECIES.	Date of Blooming.	Date of Ripening.	Hardiness.	Resistance to Disease.	Quality.	Size of Bunch.	Size of Berry.	Adhesiveness.	Keeping Qual.
Amber,	Rip. x Lab.	June 22	Sept. 24	10	9	5	s	m	6	3
Antoinette,	Labr.	“ 16	“ 23	10	9	6	l	m	4	4
Augusta,	Labr.	“ 14	“ 26	10	5	3	l	l	2	2
Belinda,	Labr.	“ 17	“ 19	10	8	6	m	m	2	2
Concord Muscat,	Labr.	“ 15	Oct. 1	9	7	2	s	s	5	2
Duchess,	Labr.-hybr.	“ 20	Sept. 13	10	8	9	m	m	8	8
Eldorado,	Labr.-hybr.	“ 17	“ 18	10	8	8	l	m	8	7
Elvira,	Rip.-hybr.	“ 13	“ 26	10	4	6	m	s	7	4
Empire State,	Labr. x rip.	“ 17	“ 21	10	3	9	m	m	8	7
Esther,	Labr. x	“ 15	“ 16	9	9	8	m	m	6	4
Etta,	Rip.	“ 13	Oct. 2	10	9	5	m	m	4	4
Faith,	Rip. x	“ 14	Sept. 11	10	9	6	s	s	5	2
Golden Drop,	Labr.-hybr.	“ 19	“ 8	8	8	8	s	s	7	5
Golden Gem,	Æst.-hybr.	“ 15	“ 12	9	8	9	s	s	8	4
Grein's Golden,	Rip.-hybr.	“ 13	“ 25	10	7	8	m	l	6	4
Hayes,	Labr.	“ 16	“ 21	10	5	9	m	m	2	2
Jessica,	Vin. ?	“ 13	“ 9	9	3	8	s	s	4	4
Lady,	Labr.	“ 18	“ 17	9	6	10	m	m	5	2
Lady Washington,	Labr.-hybr.	“ 17	“ 28	10	6	8	l	m	7	4
Martha,	Labr.	“ 20	“ 22	10	9	6	m	m	6	4
Moore's Diamond,	Labr. x	“ 17	“ 8	10	9	10	l	l	8	5
Niagara,	Labr.	“ 18	“ 26	10	7	8	l	m	8	5
Pearl,	Rip.-hybr.	“ 13	“ 28	10	5	5	l	m	5	4
Pocklington,	Labr.	“ 15	“ 24	10	9	7	l	l	5	4
Prentis,	Labr.	“ 15	“ 17	10	9	7	l	m	7	8
Rebecca,	Labr.	“ 20	“ 30	7	6	7	m	m	5	3
Seedling No. 42,	?	“ 17	“ 16	9	10	10	l	m	10	9
Seedling No. 44,	?	“ 17	“ 11	10	10	9	m	m	9	8
Transparent,	Rip. x	“ 13	Oct. 2	8	7	7	s	s	9	5
Triumph,	Labr.-hybr.	“ 20	“ 2	9	8	5	l	l	5	3
Victoria,	Labr.	“ 17	Sept. 13	8	5	6	m	m	5	5
Wilding,	Rip. x Labr.	“ 19	“ 15	9	9	6	m	s	5	3
Winchell (Green Mt.)	Labr.	“ 12	Aug. 29	10	9	9	l	m	8	6
Witt,	Labr.	“ 12	Sept. 20	9	9	9	m	m	8	6

Of the varieties described in the above tables the following deserve special mention:

Concord. Too well known to need description. While there are many better grapes, its vigor, hardiness, productiveness, fine appearance and successful growth under a great variety of conditions, make it the most popular market grape. A much earlier variety is needed however.

Eaton. A Concord seedling, vigorous and moderately productive, bunch large, shouldered, rather loose. Berry very large, juicy, very little pulp, has a fine appearance, but quality is coarse and not equal to Concord. Not valuable except for exhibition.

Herbert, Rogers No. 44. This may be considered one of the best black grapes of Rogers seedlings. The bunch is large, well shouldered and compact. Berry large, round and plump, even when over ripe. Pulp sweet, tender and while not as high flavored as some, is of the best quality. A very good keeper.

Jewel. A Delaware seedling. Healthy, hardy, but not very vigorous or productive. Bunches small, shouldered, compact. Berry small, with a heavy bloom but too dark in color, sweet, juicy and, finest quality. Keeps well for so early a grape.

Moore's Early. A seedling, somewhat resembling the Concord, but not as vigorous or productive. Bunches smaller, berries larger and about one week earlier. A profitable early market grape, but too poor in quality to be grown largely.

Nectar. A Concord-Delaware cross, moderately vigorous, healthy and productive. Bunches medium to large, compact. Berry small with a very heavy purple bloom, very handsome, pulp tender, sweet, juicy and of good quality.

Peabody. Seedling of Clinton, hardy, healthy and productive. Bunch large, long, moderately compact, partly shouldered. Berry oval, skin thin, pulp very tender and juicy, a vinous flavor unlike most table grapes. It is early and should stand shipment well. A promising variety.

Wilder. One of the best known of Rogers Hybrids, hardy, vigorous, moderately productive, bunch large, shouldered, rather loose. Berry large, resembling Black Hamburg, flesh tender, sweet, juicy, very good. An excellent keeper retaining its flavor exceptionally well.

Worden. A Concord seedling that is replacing its parent in many localities. Very similar to the Concord in bunch and berry, but about a week earlier. One of the leading market grapes and rapidly growing in favor.

Duchess. A Concord seedling crossed with Delaware, vigorous and productive. Bunch large, heavily shouldered. Skin rather thick, tough. A grape of very good quality for the table and one of the best keepers of the white varieties.

Empire State. Moderately vigorous and productive. Bunch long, medium shouldered. Of very good quality and handsome appearance. A fine table grape, but much subject to disease.

Lady. Concord seedling. A popular early white variety of good quality. Is neither vigorous nor productive here.

Moore's Diamond. From Concord and Iona, one of the best white grapes in the station collection, healthy, vigorous and productive. Bunch large, compact, heavily shouldered, berry above medium size, skin thin, but tough, very tender, sweet and sprightly. Its beautiful appearance, good quality, hardiness, productiveness and time of ripening render it of some value for home use or near market.

Winchell (Green Mountain). Vigorous, hardy and productive, bunches large, quite compact, shouldered, berry medium, skin thin, pulp tender, sweet and of excellent flavor, when fully ripe the berry shrivels. The earliest white if not the earliest of all good varieties. Especially valuable for home use as it prolongs the grape season by at least a week.

Agawam. One of Rogers Hybrids, has a very peculiar musky flavor. When grown free from disease it is desirable.

Berckman. Has been called a Delaware grape on a Clinton vine. Bunch is larger than Delaware, not as compact, berries larger, deeper color and not so attractive. Has a bright high flavor but not quite equal to the Delaware in sweetness and ripens about a week later.

Brighton. Concord and Diana Hamburg. A handsome grape of good quality. Hardy and vigorous, but somewhat susceptible to mildew and fails to fertilize unless planted with other varieties. Bunches large and well shouldered. A popular market grape in some sections.

Delaware. Needs no description. Still holds its own against all comers as the standard for quality.

Centennial. Vigorous and productive, bunch large, shouldered, Berry small, light red with a tinge of green, sweet and juicy. A good keeper retaining its flavor well into the winter. Has been called the winter Delaware. Too late for New England.

Iona. Seedling of Diana. A fine grape of the best quality, but difficult to grow and seldom ripens perfectly in this locality.

Rochester. Vigorous and productive. Bunch compact and heavily shouldered, Flavor good, sweet, very aromatic.

Vergennes. One of the best keeping grapes. Bunch medium, partly shouldered. Berry large, round, skin rather thick, tough. It retains its excellent flavor exceptionally well. Specimens have kept a year in an ordinary cold storage. Subject to mildew and rot.

Excelsior, *Highland*, *Mills*, *Secretary*, *Goethe*, *Jefferson*, *Catawba*, *Niagara*, *Triumph* and *Pocklington* are all excellent varieties, but are too late to ripen here in ordinary seasons.

Champion, *Janesville*, *Hartford Prolific*, *Telegraph* and *Early Victor* are very early black grapes of poor quality and of little value in New England.

Among the varieties of more recent introduction that are not given in the tables, *Brilliant*, *Early Ohio*, *G. W. Campbell*, *Hermann Jaeger* and *Staymans No. 44*, may be mentioned as most promising,

EXPERIMENTS WITH BLACK-CAP RASPBERRIES.

Number of Varieties Tested, 20.

The crop of Black Caps was exceptionally good. It ripened about the same time as last year.

VARIETY.	Winter-killing.	Date of Blooming.	Date of Ripening.	Vigor.	Yield from 50 Plants. Qts.	Quality.	Firmness.	Size.
Ada,	.20	June 3	July 2	8	61.5	7	9	m
Brackett's Seedling,	.15	" 1	" 4	9	109	8.5	9	m
Carman,	.10	May 30	June 28	7	29.5	8 5	9	l
Cluster,	.05	" 29	" 24	8	49	8	8	l
Corinth,	.15	June 2	July 2	8	75.8	8	9	l
Crawford,	.10	May 30	June 30	4.5	15 5	8	8.5	m
Cromwell,	.00	" 29	" 24	4.5	12	8.5	8	m
Earheart,	.20	" 27	" 25	7	27.6	7.5	8.5	m
Hilborn,	.00	June 1	" 28	9	75	8 5	9	l
Kansas,	.20	May 29	" 27	9	124 5	7.5	9	v l
Lovett,	.12	" 28	" 27	9 5	130	9	9	l
Nemeha,	.05	" 30	" 29	8	24 5	7.5	9	l
Ohio,	.15	" 31	" 29	8 5	64.5	8	9	l
Older,	.00	" 27	" 28	8.5	68	9	8	v l
Palmer,	.05	" 27	" 23	3	10 5	8.5	9	m
Progress,	.20	" 27	" 26	1	2.5	9	9	m
Smith's Prolific,	.05	June 1	" 28	7	43	8.5	9	l
Souhegan,	.20	May 27	" 25	8	31.5	8	9	m
Springfield,	.02	" 26	" 20	6	27.5	7 5	8.5	s
Columbian,*	.10	" 31	July 5	10	140	7	9	l

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*This is probably a hybrid between the red and blackcap raspberry. It closely resembles the Shaffer but is more firm but not of as good quality.

Kansas is a valuable market variety, very large, vigorous and productive, but lacking in quality.

Lovett is as large and productive as Kansas and much better in quality.

Hilborn and *Ohio* are good, well known varieties.

Older is the largest and best in quality of the Black Caps, but is a little soft for market. Well worthy a place in the garden.

Bracketts' Seedling is a very promising variety, vigorous and productive, berries firm and of good quality.

Souhegan is generally considered a good variety, but the plants seem to have lost much of their vitality and were not productive.

The raspberries, black caps and blackberries were sprayed April 12 and June 3, 1895 with Bordeaux mixture.

EXPERIMENTS WITH RED RASPBERRIES.

Number of Varieties Tested, 20.

The crop of 1895 was a little better than in 1894 and the varieties stand in about the same relation to each other. *Cuthbert*, *Marlboro* and *Thompson's Pride* have proved the most valuable on the experiment station grounds. The result of the test of varieties is shown in the following table:

VARIETY.	Winter-killing.		Date of Blooming.	Date of Ripening.	Vigor.	Yield from 50 Plants. Qts.	Quality.	Firmness.	Size.
	Covered.	NotCover'd.							
Crimson Beauty,	00	50	June 8	July 1	5	9½	9	s	s
Cuthbert,	00	20	" 7	" 3	9	86	8	f	l
Golden Queen,	00	15	" 5	" 2	9.5	123	9.5	m	l
Gladstone,	00	10	" 4	" 1	8	50	6	vs	s
Hansel,	00	10	" 1	June 23	7	52½	9	m	m
Marlboro,	00	10	" 2	" 24	8	26	8.5	f	m
Naomi,	00	25	" 6	" 30	8	34	9	m	l
Rancocas,	00	20	May 30	" 25	6	27	8.5	m	s
Scarlet Gem,	00	08	" 29	July 1	6	28	8	s	m
Staymans No. 5,	00	07	June 2	June 29	8	24	8	f	l
Thompson's Early Prolific,	00	25	" 1	" 21	8	31½	8.5	m	m
Thompson's Pride,	00	15	May 30	" 19	8	49	9	f	m
Victor,	00	30	June 4	July 1	8.5	53	8	m	l
White Mountain,	00	10	" 4	" 2	6	25	8	s	s

Thompson's Pride appears to be preferable to Hansel which has lost something of its early vigor. It is earlier, more vigorous, a little larger and firmer and of about the same productiveness. It does not, however, ripen its fruit over as long a period.

Golden Queen is exceedingly vigorous and productive and of fine quality. Should be included in every selection for the garden.

Gladstone proves entirely worthless on account of its dark, purplish color and extreme softness.

Victor, *Naomi* and *Staymans No. 1*, have good qualities, but need further trial before they can be definitely placed.

Loudon, *Royal Church*, *Talbot's Prolific* and *King*, fruited this season for the first time, and were not included in the tables. *Royal Church* crumbles so badly that it can be of little value. Unless the *Loudon* develops some undesirable qualities, not noticed in this years fruiting, it promises to be the most valuable variety yet introduced.

EXPERIMENTS WITH BLACKBERRIES.

Number of Varieties Tested, 16.

The blackberry crop of the past season on the experiment grounds was almost an entire failure due to the severe winter killing of the vines and late frosts in May. The crop was so much damaged that the records in regard to the time of ripening and value of fruit would not place the varieties in the same relation that they would bear under ordinary conditions, therefore the winter killing only is shown in the table.

All of the canes were more or less injured and the per cent given refers to the proportion that the canes were killed back. The *Snyder*, *Taylor* and *Agawam* continue to show a decided superiority over the other varieties for this locality.

Varieties.	Per cent of canes winter killed.	Varieties.	Per cent of canes winter killed.
Agawam,	60	Snyder,	15
Crystal,	90	Stones Hardy,	60
Early King,	90	Taylor,	35
Erie.	85	Topsy,	95
Fred,	80	Wachusett,	50
Lucretia,	90	Western Triumph,	80
Minnewaski,	80	Wilson,	40
Ohmer,	85	All Summer,	75

EXPERIMENTS WITH GOOSEBERRIES.

Number of Varieties Tested, 16.

The gooseberry plots contain 10 bushes of each of the new and standard varieties of the American and European gooseberries and their crosses. As they have been planted but two years no extended report is attempted. Of the American varieties, *Downing* and *Champion* made the best showing, while of the English varieties *Triumph* (an American seedling) was the largest, most vigorous and most productive. *Industry* seems very deficient in vigor and productiveness.

EXPLANATION OF TABLE.

Time of Ripening, e, early; m, medium; l, late; color; g, green; r, red.

VARIETY.	Time of Ripening.	Vigor.	Productiveness.	Quality.	Size.	Color.
Champion,	e	8	9	8	6	g
Chautauqua,	m	7	7	9	8	g
Columbus,	m	7	6	9	8	g
Crown Bob,	l	6	6	9	8	r
Downing,	m	10	10	8.5	6	g
Golden Prolific,	e	6	7	8	7	g
Houghton,	m	8	5	7	5	r
Industry,	e	5	6	10	9	r
Lancashire Ladd,	e	6	6	8	7	r
Lewis Roesche,	m	7	7	10	8	g
Pale Red,	m	9.5	10	7	5	r
Pearl,	m	8	5	7	7	g
Red Jacket,	l	8	8	9	7	r
Smith's Improved,	e	8	6	9	7	g
Triumph,	m	9	8	8	10	g
White Smith,	m	6	7	7	9	g

EXPERIMENTS WITH STRAWBERRIES.

Number of named Varieties Tested 155, and 150 Seedlings.

The plants in the experiment plots suffered but little from the late frosts or from attacks of insects and disease, and made a very even growth, nearly every variety making a good stand. They were sprayed Aug. 4, 1894 and April 19, 1895 with Bordeaux, and again May 6 with Bordeaux and Paris Green 1 lb. to 250 gals. They were given a mulch of marsh hay the first of December, and with the exception of *Marshall*, *Middlefield*, *Triumph* and *Florence*, came through the winter about equally well.

The plants were set 18 inches apart, in rows three feet apart, and on one-half of the row, each plant was allowed to set two runners, one on each side of the interval between the plants. On the other half, each plant was allowed to set five runners; one on each side of the original plant and three across the interval. In most cases the results were in favor of the latter method.

The fruit was weighed as picked but, as visitors were allowed to test the fruit more or less these weights were not wholly relied upon, being used together with observations, to make up the productiveness on a scale of ten. The following table shows the results of the plot trials for 1895:

EXPLANATION OF TABLE.

In vigor, productiveness and quality 10 indicates the nearest perfection. Sex, b, bisexual, p, pistillate; size, l, large, m, medium, s, small; form, r, round, c, conical, l, long, ir, irregular; firmness, f, firm, m, medium, s, soft; color, c, crimson, s, scarlet, l, light, d, dark.

VARIETY.	Sex.	Vigor.	Date of Blooming.	Date of Ripening.	Date of First Picking	Date of Last Picking	Productiveness	Size.	Form.	Quality.	Firmness.	Color.
Accomac,	B	7	May 7	June 7	June 10	June 26	4	l	lc	8	f	dc
America,	B	4	" 6	" 5	" 8	" 26	3	m	rc	9	f	ds
Anna Forest,	B	9	" 8	" 4	" 8	" 28	9 5	l	rc	8.5	s	lc
Aroma.	B	7.5	" 10	" 10	" 12	" 26	8.5	l	rc	9	m	bc
Auburn,	P	8	" 5	" 1	" 8	" 26	8	m	c	8.5	m	dc
Barton's Eclipse,	P	6.5	" 7	" 3	" 8	" 26	8.5	l	lc	7.5	f	m
Beaver's No. 3,	B	6	" 15	" 10	" 12	" 26	4	m	r	8	m	m
Beder Wood,	B	7	Apr. 30	" 2	" 8	" 26	8.5	m	r	7	m	lc
Beede,	B	7.5	May 7	" 4	" 8	" 26	8	l	ir	8	m	m
Belle la Crosse,	B	7	" 5	" 8	" 10	" 28	7	m	rc	7.5	m	bs
Belmont,	B	8	" 12	" 10	" 14	" 28	7.5	l	lc	9	f	c
Beverly,	B	8	" 9	" 8	" 10	" 28	8 5	l	rc	9	f	dc
Bostonian,	B	9	" 15	" 13	" 15	" 28	7	m	c	8	m	c
Boynton,	P	7	" 7	" 6	" 10	" 28	7	m	r	8	m	lc
Brandywine,	B	8	" 7	" 5	" 8	" 28	8	l	rc	8	m	dc
Brigg's Seedling,	B	6	" 6	" 8	" 8	" 28	7.5	s	c	8	f	dc
Bubach No. 5,	P	8	" 7	" 5	" 10	" 26	7	l	cf	9	m	lc
Chairs,	B	6	" 7	" 5	" 8	" 26	8	m	rc	7.5	m	c
Charley,	P	8.5	" 7	" 4	" 8	" 26	8.5	m	c	8 5	m	l
Chas. Downing,	B	8	" 7	" 9	" 10	" 26	8	m	rc	9	m	lc
Clark's Seedling No. 1	P	6	" 5	" 3	" 5	" 26	7	m	lc	8.5	m	dc
" " No. 2	B	8	" 7	" 6	" 8	" 26	9	m	rc	8	s	c
" " No. 3	B	6	" 7	" 6	" 8	" 26	6	m	ir	7	s	dc
Crawford,	P	6	" 4	" 2	" 8	" 26	8	m	c	8	m	c
Crawford No. 51,	B	7.5	" 8	" 9	" 12	" 28	7	l	ir	7.5	m	dc
Crescent,	P	8	" 4	" 4	" 10	" 26	9 5	m	rc	7	m	s
Cumberland,	B	10	" 9	" 6	" 8	" 28	10	l	r	8.5	s	ls
Cutter's Seedling,	B	8.5	Apr. 29	" 2	" 5	" 26	7.5	s	lc	9.5	m	s
Cyclone,	B	5	May 4	" 1	" 5	" 24	7	s	l	7.5	m	dc
Davis No. 2,	B	8.5	" 9	" 10	" 14	" 26	6	l	r	8.5	m	lc
Dayton,	B	7	" 4	" 2	" 8	" 20	6.5	l	rc	7	f	lc
Dew,	B	8	" 10	" 13	" 14	" 26	6	vl	ir	7.5	f	dc
Dow,	B	6	" 3	" 1	" 5	" 17	2.5	s	lc	8	s	dc
Dutton,	B	7.5	" 9	" 9	" 14	" 26	3	l	c	8.5	m	c
Edgar Queen,	P	8	" 3	" 3	" 8	" 26	9	l	ir	8	s	lc
Edith,	P	7	" 16	" 12	" 14	" 28	7	vl	ir	8	m	c
Edward's Favorite,	B	7.5	" 9	" 9	" 10	" 28	7	m	lc	7.5	s	c
Enhance,	B	9	" 4	" 6	" 8	" 26	9.5	l	ir	7	f	dc
Epping,	P	8.5	" 5	" 2	" 5	" 26	8.5	l	rc	8.5	f	s
E. P. Roe,	B	8	" 9	" 9	" 14	" 30	6	l	lc	7	s	l
Equinox,	B	6.5	" 8	" 8	" 14	" 28	6.5	m	ir	6.5	s	ds
Eureka,	P	8	" 10	" 7	" 12	" 26	3.5	l	c	8.5	m	c
Fairmount,	B	6.5	" 10	" 6	" 10	" 26	2.5	l	lc	8.5	m	dc
Felton,	B	7	" 10	" 9	" 12	" 26	3	l	ir	9	m	dc
Florence,	B	8	" 14	" 10	" 12	" 26	6	m	c	8	f	c
Fremont,	B	8	" 10	" 9	" 12	" 26	7.5	m	c	8.5	f	c
Gandy,	B	7	" 14	" 10	" 12	" 28	6	m	c	8.5	f	s
Glendale,	B	7.5	" 8	" 9	" 10	" 28	6	m	ir	8.5	m	dc
Glen Mary,	B	8	" 4	" 4	" 8	" 26	7.5	l	lc	8	m	dc
Golden Defiance,	P	9	" 10	" 10	" 12	" 28	9.5	l	c	8.5	m	c
Gen. Putnam,	P	8	" 4	" 6	" 8	" 26	10	l	r	8	s	ls

VARIETY.	Sex.	Vigor.	Date of Blooming.	Date of Ripening.	Date of First Picking	Date of Last Picking	Productiveness.	Size.	Form.	Quality.	Firmness.	Color
Gov. Hoard,	B	8	May 8	June 6	June 8	June 26	7	l	ir	9	f	dc
Gillespie,	B	7.5	" 9	" 8	" 10	" 22	5.5	l	lc	8.5	s	lc
Greenville,	P	7.5	" 9	" 5	" 8	" 26	8.5	l	c	8	m	c
Haverland,	P	6	" 3	" 3	" 8	" 26	9	l	lc	8.5	m	s
Howard's No. 1,	P	8.5	" 30	" 3	" 8	" 26	8	l	lc	9	f	c
" No. 14,	P	9.5	June 9	" 5	" 8	" 26	8.5	l	lc	9.5	m	c
" No. 23,	P	5	" 7	" 4	" 8	" 26	8	m	lc	8	m	dc
" No. 25,	B	7.5	" 4	" 2	" 5	" 26	6	m	lc	7.5	f	c
" No. 28,	P	6.5	" 7	" 6	" 8	" 26	8	m	r	8.5	m	c
" No. 30½,	P	6.5	" 9	" 8	" 12	" 28	7.5	m	l	7	m	c
" No. 36,	P	7.5	" 7	" 4	" 8	" 26	8.5	m	lc	8	f	c
" No. 41,	P	5	" 4	" 5	" 8	" 26	8	s	ir	9	m	dc
" No. 501,	B	4	" 7	" 7	" 12	" 28	6.5	m	c	8.5	f	c
" No. 601,	B	4.5	May 30	" 5	" 8	" 26	6.5	m	c	7	m	c
" No. 605,	B	5	" 30	" 5	" 8	" 26	6	m	r	8.5	m	c
Huntsman,	B	4	" 7	" 7	" 8	" 24	3	s	r	8.5	m	dc
H. W. Beecher,	B	6	" 13	" 10	" 14	" 24	2	m	rc	9	m	dc
Idaho,	B	4	" 4	" 5	" 8	" 26	8	s	rc	8	m	c
Iowa Beauty,	B	4.5	" 4	" 5	" 7	" 26	6	s	rc	8	s	c
Jay Gould,	P	7.5	" 9	" 7	" 10	" 26	5.5	m	rc	8.5	s	c
Jucunda,	B	8	" 13	" 9	" 12	" 26	7.5	l	c	9	f	d
Judsonia,	B	8	" 10	" 6	" 8	" 28	8.5	l	ir	9	m	dc
Katie,	P	7	" 10	" 9	" 10	" 26	4.5	s	r	7	m	c
Klickita,	P	9	" 12	" 9	" 12	" 26	3.5	l	c	8	m	c
Laxton's Captain,	P	4	" 7	" 10	" 14	" 24	2	l	ir	8.5	m	dc
Laxton's Commander,	B	5.5	" 7	" 7	" 8	" 26	3.5	m	r	7	m	c
Leader,	B	7	" 4	" 4	" 8	" 26	7.5	m	r	8.5	m	dc
Leroy,	P	8	" 7	" 5	" 8	" 26	5	l	c	9	f	dc
Loudon,	B	7	" 7	" 6	" 8	" 26	6	m	c	7.5	f	dc
Lovett's Early,	B	7	" 7	" 5	" 8	" 26	7.5	m	ir	8	m	c
Luther,	B	6	" 3	May 31	" 5	" 24	7	m	l	9.5	m	c
Marshall,	B	8	" 5	June 3	" 8	" 28	6.8	l	rc	9.5	m	dc
Martha,	P	5	" 6	" 7	" 12	" 26	8	s	ir	7	m	dc
Mary,	P	6	" 13	" 12	" 14	" 26	6	l	ir	7	s	dc
Marston,	P	7	" 4	" 3	" 5	" 26	6.5	m	c	8.5	m	c
Mrs. Cleveland,	P	7	" 5	" 1	" 5	" 24	6	m	r	8	m	dc
Moore,	B	6	Apr. 29	" 1	" 8	" 26	6	m	r	8	m	c
Meek's Early,	B	5	" 5	" 4	" 8	" 26	6	m	r	8	m	c
Middlefield,	P	8	" 9	" 7	" 10	" 26	5.5	l	c	8.5	f	s
Miner's Prolific,	B	7	" 4	" 9	" 10	" 26	6	m	c	8.5	m	c
Mt. Holyoke,	B	5	" 8	" 6	" 8	" 26	5	m	c	8	f	c
Michels' Early,	B	7	" 3	" 1	" 5	" 18	5.5	s	lc	9	f	s
Muskingum,	B	7	" 7	" 5	" 10	" 28	7.5	l	r	8.5	m	d
Mystic,	B	9	" 10	" 10	" 12	" 26	6.5	l	r	9	m	dc
Nehering's Gem,	P	8	" 10	" 8	" 10	" 26	6.5	l	ir	9	m	c
Norther's Seedling,	B	8	" 3	" 8	" 10	" 26	6	l	ir	8.5	m	c
Norwood,	B	6	" 7	" 6	" 8	" 24	7	m	rc	8	m	c
Ohio Centennial,	B	8	" 9	" 3	" 5	" 28	7.5	l	ir	8.5	m	c
Oliver,	B	7	" 12	" 10	" 14	" 30	8	l	c	8.5	m	c
Omega,	P	8	" 3	" 5	" 8	" 28	8	m	ir	8	f	s
Orange County,	P	6	" 3	" 4	" 8	" 28	6	m	r	9	s	ls

VARIETY.	Sex.	Vigor.	Date of Blooming.	Date of Ripening.	Date of First Picking	Date of Last Picking	Productiveness.	Size.	Form	Quality.	Firmness.	Color.
Oregon,	B	7	Apr. 4	June 7	June 10	June 28	5	m	c	7	m	c
Otsego,	P	8	" 7	" 9	" 10	" 26	8	s	r	8	m	c
Our Choice,	P	9	" 9	" 8	" 10	" 26	9	m	r	8.5	s	c
Ona.	P	7.5	May 7	" 3	" 5	" 24	8.5	m	rc	9	s	c
Pacific,	P	7	" 6	" 3	" 8	" 26	9	l	rc	9	m	dc
Parker Earle,	B	9	" 9	" 9	" 12	" 30	8 5	l	lc	8.5	m	c
Phillip's Seedling,	B	6	" 7	" 3	" 8	" 26	7	l	ir	8	m	c
Pioneer,	B	7	" 4	" 8	" 10	" 26	6	m	r	8.5	m	s
Perpetual,	P	4	" 4	" 2	" 5	" 24	5	s	c	8	m	dc
Pomona,	B	7	" 6	" 5	" 8	" 26	8	l	rc	9	f	c
Princess,	P	5	" 9	" 7	" 8	" 26	7	m	rc	9.5	m	lc
Princeton Chief,	P	8	" 9	" 8	" 10	" 28	8	m	l	8	f	dc
Regina,	P	7	" 12	" 9	" 10	" 26	6	m	rc	8	f	dc
Rheil's No. 1,	P	5	" 4	" 3	" 8	" 24	3	s	r	7	m	s
Richmond,	B	6	" 8	" 9	" 10	" 26	4	l	ir	8	f	c
Rio,	B	6	" 4	" 2	" 5	" 20	7	l	rc	9.5	f	s
Sam,	B	6	" 9	" 7	" 10	" 26	6.5	m	c	8	f	c
Sandoval,	B	7	" 8	" 7	" 12	" 26	6.5	l	c	8	m	c
Sanders,	B	5	" 18	" 8	" 10	" 26	4	l	r	7.5	m	dc
Seedling B,	P	8	" 9	" 6	" 15	" 28	6.5	l	rc	9	m	c
Seedling No. 24,	B	6	" 9	" 8	" 12	" 28	6.5	vl	c	7.5	s	dc
" No. 35,	B	5	" 3	" 3	" 8	" 28	7	m	c	8	s	s
" No. 40,	B	8	Apr. 30	" 5	" 8	" 26	6.5	m	c	9	f	c
" No. 45,	B	5	May 4	" 5	" 8	" 24	4.5	m	c	9	f	dc
" No. 47,	P	5	" 3	" 2	" 5	" 26	7.5	s	c	8	m	c
" No. 48,	B	6	" 4	" 4	" 8	" 28	7	vl	c	7.5	s	ls
Sharpless,	B	7	" 4	" 9	" 12	" 26	5	l	ir	9	m	c
Shaw,	B	6.5	" 10	" 8	" 12	" 26	5	m	r	8	m	dc
Stone's Seedling,	B	7.5	" 6	" 3	" 5	" 20	8	m	rc	8 5	s	c
Sherman,	B	4	" 7	" 7	" 8	" 26	5.5	l	c	9	s	c
Shuckless,	B	7	" 9	" 6	" 8	" 28	6	m	c	8 5	f	lc
Smith's Seedling,	B	7	" 7	" 7	" 10	" 28	7	l	ir	7	s	dc
Southard,	B	6	" 8	" 5	" 8	" 26	7.5	m	ir	8	s	dc
Standard,	B	7	" 7	" 6	" 8	" 26	9.5	l	c	8 5	s	c
Sterling,	P	6	" 9	" 7	" 12	" 26	3	m	c	8	s	c
Stevens,	B	6	" 4	" 2	" 5	" 26	5 5	s	r	7	f	s
Sunnyside,	P	6	" 7	" 4	" 8	" 26	8.5	m	c	8 5	s	c
Swindle,	P	4	" 8	" 7	" 10	" 26	5	m	c	7	f	dc
Tennessee Prolific,	B	7	" 8	" 7	" 10	" 30	8.5	l	ir	9	f	c
Thompson,	B	7	" 1	" 1	" 8	" 26	8.5	l	ir	9	f	dc
Thompson's 66,	P	6	" 9	" 5	" 8	" 26	6.5	m	lc	7.5	f	dc
Timbrell,	P	8	" 10	" 10	" 12	" 30	8	l	c	9.5	f	lc
Townsend's No. 20.	P	8	" 9	" 7	" 10	" 26	6	m	c	9	m	dc
Van Dieman,	B	8	" 4	" 3	" 5	" 22	8.5	l	c	8	m	dc
Warfield,	B	7	" 4	" 4	" 8	" 28	9.5	m	rc	8	f	dc
Westbrook,	P	8	" 1	" 3	" 5	" 22	6	s	c	8.5	m	c
West Lawn,	P	8	" 2	" 3	" 8	" 22	7	m	c	8	m	c
Wentzel,	B	8	" 9	" 7	" 8	" 24	6.5	s	rc	8.5	s	c
Williams,	B	6.5	" 15	" 9	" 10	" 28	6	l	c	8.5	m	dc
Wilson,	B	5	Apr. 29	" 6	" 8	" 24	6.5	s	rc	8.5	s	c
Wolverton.	B	8	May 18	" 9	" 12	" 28	7	l	rc	8.5	f	dc

The following varieties mostly of recent introduction, have given evidence of some merit, and a more detailed account is given than can be found in the table.

Aroma. The plants are moderately vigorous and productive. Fruit large, bright crimson and of high quality. Valuable for home garden.

Charlie. Vigorous and very productive. Fruit of good form, firm enough for near market, but a little too light colored to make a good seller.

Cumberland. An old variety not much grown, but for vigor and productiveness unsurpassed. The berries are large and of very good form and quality but their light color and soft texture detract much from the value as a variety for market.

Edith. Plants are of short and stocky growth. Berries the largest of any variety. The first to ripen were coxcomb in form and very irregular, but later were more regular and of better quality. It ripens late, but is not productive enough to be of much value for market.

Epping. Plants made a vigorous growth of light colored foliage. It ripened with the earliest and was the most productive of any variety in the field test. The berries were medium to large, moderately firm and of good quality. The color is light scarlet. It is one of the most promising of the newer varieties.

General Putnam. Vigorous and very productive. The berries are large and very regular in form but are too soft and light colored. May be valuable for near-by market.

Jucunda Improved. An improved type of Jucunda. Vigorous but not productive. The berries are a rich crimson color with prominent yellow seeds, of excellent quality, perfect form and even size. In appearance it is excelled by none; and, while not productive enough to be profitable for market, it might well be given a place in the home garden.

Leader. This popular variety made a good growth, blossomed very profusely and set a large amount of fruit. The last of May, it was the most promising variety on the grounds, but it seemed to lack the vitality to carry out the fruit it had set. Berries medium to large, regular in form and of fair quality. It blooms early and is a good pollenizer.

Governor Hoard. Plants strong and stocky. Berries large, inclined to be irregular, crimson, firm and good quality. A good shipper, but lacks in productiveness.

Lovett. Is vigorous and productive. Ripens mid-season, medium size, irregular, fair quality, moderately firm. A good variety for market and for fertilizing the medium early pistillate varieties.

Luther. Ripened with the earliest. The first berries to ripen were large, bright crimson, very regular, and of superior quality. After a few pickings however, they became small and of little value. If this variety can be grown with sufficient vitality to carry out its fruit, it will prove one of the most valuable.

Marshall. This variety has probably received more favorable comment than any other of recent introduction. It is one of the most vigorous in growth, and produces a large quantity of very large, beautiful, dark crimson berries of regular form and superior quality. It appears, however, to be very tender both in foliage and blossom. It readily succumbs to attacks of leaf blight and more than 90 per cent of the foliage winter killed. The plants made a strong growth of new foliage however, but the crop was injured in the blossom by the late spring frost, the small amount of fruit that matured being malformed. Needs further testing before it can be recommended for general culture.

Our Choice. Vigorous and productive. Berry of good form and fair quality, but too soft for long shipment. Valuable for home market because of its productiveness.

Ona. A healthy grower. Ripens with the earliest, very good quality, form and color. A little soft, but otherwise very promising.

Pacific. Made a good growth and was very productive. The fruit is large, of good quality and appearance.

Princess. Plants healthy, but not vigorous, and moderately productive. Fruit medium size, of good appearance and very superior quality. Valuable where quality is appreciated.

Rio. A very good, early variety. Plants productive, but not vigorous. Berries of large, even size and regular form.

Standard. Very productive. Fruit large and of fair quality, but rather soft for shipping.

Tennessee Prolific. Makes a strong growth of healthy foliage. Fruit large, a little irregular, bright color, firm and of good quality. Ripens medium early, but continues to ripen fruit with the latest. A very good variety for home, garden and market.

Thompson's Prolific. Plants strong, healthy and productive, berries large, irregular, firm and of excellent quality. Blossomed with the first and ripened a few berries very early, but was at its best about mid-season. Very promising.

Timbrell. *Vigorous*, productive and of excellent quality, but worthless for market because of its mottled color.

Van Dieman. The best in quality and appearance, and the most productive of the very early varieties. Berries large, firm, regular and of a brilliant, glossy, scarlet color with prominent seeds. The foliage is, however, rather tender and susceptible to rust.

Wolverton. A good market berry and very good as a pollenizer for the mid-season berries. Very productive, fruit large, firm and of good quality and appearance.

Brandywine. Plants are vigorous and productive. Fruit large, of fair quality and medium firm. Promises to be a valuable addition.

Parker Earle. This very late, vigorous variety possesses much merit. It is immensely productive, makes few runners and sets so much fruit that it is unable to mature it. It is possible that by high feeding and thinning out the late blossoms it may be found profitable.

Howard's Nos. 1 and 14, seedlings from a Haverland-Belmont cross, are promising varieties from Mr. A. B. Howard of Belchertown. They resemble each other, but No. 14 is more vigorous and productive, while No. 1 is the earlier of the two. In form and appearance they resemble Haverland, but the fruit stalks are more erect and the quality better.

Seedlings. A large number of chance seedlings were fruited the past season for the first time and many of them attracted much attention from visitors and were of fine quality. All will be fruited again the coming season and those that gave the most promise be propagated for more extended trial.

The following we would place as the ten best varieties: Bubach, Haverland, Greenville, Parker Earle, Golden Defiance, Wolverton, Leader, Brandywine, Epping, Van Dieman.

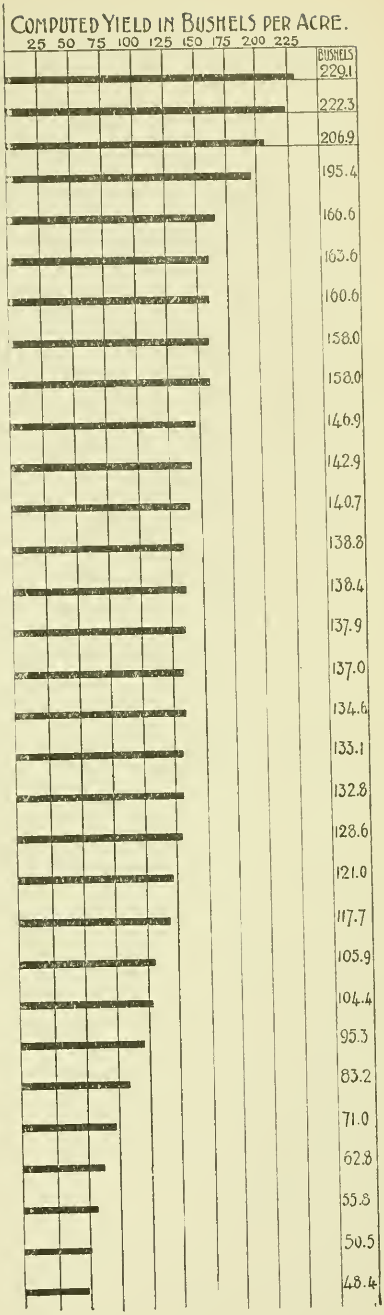
The following varieties have been discarded from the lists as unworthy of further trial: Alabama, Cornelia, Dow 31, Martha, Middlefield, Miner's Prolific, Mt. Holyoke, Rheil's No. 1, Sandoval, Sanders, Fairmount, Florence, Sterling, Stevens, Swindle, Westbrook, Hinsmore, Lady Rusk, Miller's Seedling, Parmenter's Seedling, Sadie, Smeltzer Early, Waldron and Yale.

EXPERIMENTS WITH STRAWBERRIES UNDER FIELD CULTURE.

Those varieties which had shown decided value in the experiment plots were given a trial in ordinary field culture. They were planted in rows three feet apart and two feet apart in the row. In one-half of each row the original plants were allowed to set five runner plants, one on either side, and three across the interval, between it and the next plant; the other half being left to grow in matted row. The fruit in the first half was of larger size, and ripened about two days earlier than that in matted rows. The beds were given a light covering of marsh hay after the first freeze except a check space in the centre of about one rod wide which was left uncovered. The land having been covered with snow most of the winter however there was little difference seen between the covered and uncovered plots, except that the weeds started earlier and with more vigor on the latter than on the former. The following table shows the dates when the first, largest and last pickings were made, the yield per row previous to June 11th and after June 25th, and the total yield per row given in boxes. Considerable injury was done by late frosts, the varieties suffering most being the *Marshall* and *Sharpless*.

VARIETY.	Date of First Picking	Am't Picked Previous to June 11.	Date of Largest Picking	Date of Last Picking	Am't Picked after June 25.	Total Yield per Row.
		Box's			Box's	Box's
Beder Wood,	June 6	26.8	June 15	June 27	1	108.2
Belmont,	" 13	0	" 21	July 3	7.5	55
Beverly,	" 10	1	" 19	June 29	9	93
Brandywine,	" 10	2	" 15	" 28	8	106.2
Bubach,	" 8	6.2	" 19	" 29	2.2	98.8
Chas. Downing,	" 12	0	" 26	" 29	30	69
Crescent,	" 6	12	" 15	" 29	1	90.8
Cutter's Seedling,	" 6	8.2	" 15	" 28	1	46.8
Epping,	" 10	2	" 18	" 28	14.2	151.5
Eureka,	" 15	0	" 24	" 29	27	104.5
Gandy,	" 11	0	" 21	" 29	14.5	63
Gov. Hoard,	" 10	1	" 21	" 29	5	70
Golden Defiance,	" 13	0	" 21	" 29	10	104.5
Greenville,	" 6	8.2	" 17	" 29	5.8	129.2
Haverland,	" 7	12.2	" 18	" 29	2.2	88
Jucunda Improved,	" 10	1	" 26	" 28	32	80
Leader,	" 8	9.5	" 21	" 28	3.5	77.8
Lovett,	" 8	5	" 20	" 29	2	91.8
Mrs. Cleveland,	" 10	4	" 20	" 28	6.5	85
Michel's Early,	" 6	28.8	" 16	" 26	1	89
Marshall.	" 13	0	" 22	" 28	3	22
Our Choice,	" 8	18	" 20	" 28	7.5	147
Oliver,	" 20	0	" 26	July 3	15	41.5
Pacific,	" 8	3	" 20	June 28	11	91.5
Parker Earle,	" 15	0	" 26	July 3	26	91.2
Shaw,	" 15	0	" 26	June 28	9	33.4
Seedling No. 24,	" 15	0	" 26	July 3	23	87.8
Standard,	" 10	2.5	" 22	June 28	20	136.8
Sharpless,	" 14	0	" 22	" 28	11	39
Timbrell,	" 15	0	" 22	July 3	18	94.5
Wolverton,	" 12	0	" 18	June 28	9.5	112.5

The following diagram shows the relative yield of the varieties fruited under field culture, and the yield per acre computed from the yield per row covering 900 square feet. It will be seen that the results in the field do not quite agree with those obtained in the plots which may be in part explained by a slight difference in the soil conditions and in part by a little more thorough cultivation in the latter than in the former.



VARIETY.	BUSHELS
Epping,	229.1
Our Choice,	222.3
Standard,	206.9
Greenville,	195.4
Wolverton,	166.6
Beder Wood,	163.6
Brandywine,	160.6
Eureka,	158.0
Golden Defiance.	158.0
Bubach,	146.9
Timbrell.	142.9
Beverly,	140.7
Lovett,	138.8
Pacific,	138.4
Parker Earle,	137.9
Crescent,	137.0
Michel's Early,	134.6
Haverland,	133.1
No. 24,	132.8
Mrs. Cleveland,	128.6
Jucunda Improved,	121.0
Leader,	117.7
Gov. Hoard,	105.9
Chas. Downing,	104.4
Gandy,	95.3
Belmont,	83.2
Cutter's Seedling,	71.0
Oliver,	62.8
*Sharpless,	55.8
Shaw,	50.5
*Marshall,	48.4

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*Seriously injured by frost.

DIRECTIONS FOR THE USE OF FUNGICIDES AND INSECTICIDES FOR THE SEASON OF 1896.

S. T. MAYNARD.

During the past season, farm and garden crops were more largely exempt from serious injury by fungous pests than usual, owing to various causes, but largely because of the extremely dry weather which has been unfavorable for fungous growth, but favorable for insect development.

The beneficial results of the use of fungicides and insecticides for the past three or four years, however, make it certain that we cannot afford to run the risk of being unprepared, but should always use the best known remedies for insect and fungous pests as a matter of regular routine,in the same way as we fertilize or cultivate our crops, and we find many of the best growers are equipping themselves for the work with the most approved appliances.

The season for the treatment of our fruit crops to prevent injury from insects and fungous growths is fast approaching, and we give below directions for this work based upon the results of our own experiments, those obtained by other stations and from the results of individual practical growers. We would urge the importance of a *thorough application* in all cases of the fungicide, especially the first spraying, when the trees are dormant, as no possible harm can be done and the liberal amount of copper thus applied will be distributed over the tree after the leaves are unfolded.

COMBINED INSECTICIDES AND FUNGICIDES.

While the work of this division is largely confined to the study and treatment of fungous diseases, we have combined insecticides and fungicides, because such combination can be applied more economically than if each is applied separately.

FUNGICIDES.

Nothing has been discovered during the past year that is more effective or better adapted to general use as a fungicide than the Bordeaux mixture and the Ammoniacal Carbonate of Copper.

BORDEAUX MIXTURE.

Formula. 4 lbs. Copper Sulphate, (*Blue Vitriol*).
4 lbs. Caustic Lime (Unslaked Lime).

Dissolve the Copper in hot water. (If suspended in a basket or sack in a tub of cold water it will however dissolve in from two to three hours.)

The Lime is then slaked in another vessel adding water slowly that it may be thoroughly slaked. When both are cool, pour together, straining the lime through a fine mesh sieve or burlap strainer, and thoroughly mix. Before using, add water enough to make

(A) 25 gallons of the mixture or
(B) 50 " " " "

The active agent in this mixture is the copper, the lime being used simply to hold it in place upon the foliage and branches of the plants sprayed. Here it is given up gradually, destroying the spores of the fungi as they are brought in contact with it by the surrounding atmosphere.

Should the lime be air slaked, more than four pounds may be needed as it will have lost much of its strength.

AMMONIACAL CARBONATE OF COPPER.

Formula. 3 oz. Carbonate of Copper.
Liquid ammonia enough to dissolve the Copper, which will be about 3 qts., varying somewhat according to its strength.

Before using, dilute with water to 25 gallons.

This mixture is to be used after the fruit approaches ripening, when it would be disfigured by the Bordeaux mixture.

DRY BORDEAUX MIXTURE.

The difficulty often experienced in using the liquid Bordeaux mixture, from the pumps getting out of repair, the nozzles clogging, or the disfigurement of horses, harness, trees and other objects has led to a demand for something less objectionable and more easily applied. To meet this demand there has been manufactured in many places the powdered or dry Bordeaux mixture.

If properly made these powders contain the same ingredients as the liquid Bordeaux and in the same form, i. e. Hydrated oxide of Copper and Calcium oxide. This has been shown by the analyses of ten samples sent in by the horticultural division to the laboratories of the station, but it is doubtful if it can be made to adhere as firmly to the foliage as the liquid form and we know of no experiments where its value has been proved. Although it has not been determined whether the lime, especially when in a fresh state, will be wholly harmless on all kinds of foliage, or whether Paris green or other insecticides can be used with it equally well, with the modern improved methods of applying powders to plants and trees, yet we would recommend a careful trial of this substance. The great difficulty in its use will be in selecting times for its application when the foliage is wet with rain or dew without which it will not adhere. To make the powder more adhesive it is suggested to add an equal amount of very fine dry flour, thoroughly mixed with it. When moistened this will adhere for a long time to the foliage and probably will give up the copper readily enough with each rain to serve the purpose of destroying all spores of fungi that may come in contact with it.

To apply this dust to tall trees, a long tube will be needed to conduct it nearer to the point of distribution, otherwise there will be a great loss of material. The cost of this mixture should not be very great as all the materials of which it is made are cheap and it could be readily prepared by the consumer, by making a moist Bordeaux mixture and drying the precipitate, but for the necessity of making it very fine by grinding.

INSECTICIDES.

For general purposes two insecticides only are used. Paris green for all chewing insects and kerosene emulsion for sucking insects.

Paris Green. This is too common a substance to need description and is used in preference to London purple because it is more uniform in composition and results than the latter.

Many cases of injury to the foliage have been reported from the use of Paris green and as far as now determined this injury is in proportion to the amount of soluble arsenic or arsenious acid contained in the sample used. Several samples of pure Paris green obtained from reliable manufacturers, as analysed at the station laboratory, show the following composition:

Samples.	No. 1.	No. 2.	No. 3.
Moisture	1.38	1.05	.67
Arsenious acid	54.85	54.14	53.73
Copper oxide	32.55	31.05	30.60

Arsenious acid soluble in cold water 4 per cent.
" " " " boiling " 8 to 9 per cent.

If, as we have reason to believe, the injury is in proportion to the amount of soluble arsenic in the Paris green, the injury, so often reported, may be due to putting this substance into heated lime mixtures, to the heat generated by the chemical action in mixing the two or to the heat developed by the sun on globules of water standing on the leaves. If therefore the above be correct Paris green should never be put into liquids until thoroughly cooled. These points however, will receive careful investigation and the results be reported in a future bulletin. It is well known, that by adding the milk of lime to the water containing Paris green or by using the latter with the Bordeaux mixture, much more of this insecticide can be used and little or no injury result, than if used in water alone. One gallon of the milk of lime to ten gallons of the water containing Paris green as ordinarily used, i. e. 1 lb. to 150 or 200 gallons of water, will be sufficient.

The use of the Bordeaux mixture has become a necessity to protect most of our crops from fungous pests and as the lime in this mixture has the same effect as the milk of lime, we urge their combined use, thus reducing the cost for the destruction of each pest to the minimum.

THE "NEW PROCESS" PARIS GREEN.

The "new process" Paris green, as shown by the analysis of several samples made by the chemical department of this station *is not Paris green* at all, but a combination of lime and arsenious acid with a small amount of copper oxide.

This article is offered for sale by some of the large dealers in seeds and horticultural supplies in this and other states, and as many reports have come to us of its having seriously injured the foliage when used last summer, we would advise those intending to use this material the coming season to make a very careful trial on a small scale before applying it to the valuable crops. The analysis of these samples shows the following:

Arsenious acid	58 to 63			per cent.
Lime	14	"	16	"
Copper oxide	7	"	8	"
Arsenious acid soluble in water ordinary temperature	3	"	4	"
" " " " " boiling point	15	"	20	"

In view of the greater solubility of the arsenious acid in this material at a high temperature more care may be needed to avoid increasing the temperature of the liquid with which it is used.

KEROSENE EMULSION.

Formula. $\frac{1}{2}$ lb. common bar soap,
2 gallons common kerosene.

Cut the soap into small pieces or shavings and dissolve in about two gallons of hot water. While still hot, pour in the kerosene and with the hand pump or syringe, pump it back and forth until a thick butter-like substance is formed. In this condition the kerosene is divided into very minute globules and will be readily diluted or suspended in water.

Before using, add water enough to make

(A) 10 gallons of emulsion
(B) 20 " "

EQUIPMENT FOR SPRAYING.

Pumps. To obtain the best results, both insecticides and fungicides should be put on in as fine a spray as possible. When any liquid is applied in a stream, much of it runs off and is wasted, while if put on in a fine mist it adheres in minute drops which, when dry are held firmly by the hairs and uneven surfaces of the leaves.

In different sections of the country, pumps are being manufactured especially adapted for the application of fungicides and insecticides and many of them have reached a good degree of perfection. Without advertising any one of them as superior to others, we would advise purchasing from reliable manufacturers and those located as near home as possible. This last is very important that in case of breakage or injury, parts of the pump may be obtained in as short time as possible.

KNAPSACK PUMP.

The knapsack or the small garden pumps are found very efficient for small trees when closely planted or where only a small number are to be treated, but for large trees and in plantations of considerable extent the barrel or power pump is more economical.

BARREL AND POWER PUMP.

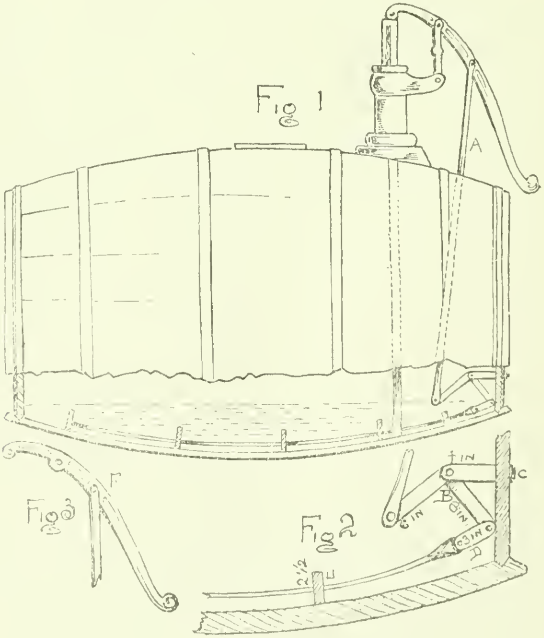
The hand pump attached to a barrel or tank and mounted on a low wagon or stone-boat is largely used and when worked in a systematic manner is very satisfactory. Many efforts however, have been made to improve on this method which have resulted in the production of several power spraying pumps, some of which are run by gearing attached to the wheels and others by a small engine mounted on a low truck. One of the most approved forms of the former has been in use two seasons in the work of this department and has given good satisfaction and materially reduced the cost of the work.

STEAM PUMP.

For the steam pump it is claimed that more power is applied, that the power can be applied more quickly and shut off more quickly, that three or more streams can be used at once, that the hose can be carried into tall fruit trees, elms and maples and other ornamental trees, that the cost of fuel is very small and where large areas are to be sprayed it is more efficient and economical.

To determine the value of the steam spraying pump this department has equipped itself with an oil engine and pump guaranteed to throw three streams at once 50 feet high and to stand the strain of driving over rough land. The engine and pump weighing about 300 lbs. are mounted on a low truck with wheels having 6 inch tires and weighing about 800 lbs.; the tank to be used holding 150 gallons.

It must be borne in mind in the use of any pump, no matter how well constructed, that it is liable to get out of order and the manipulator should fully understand the construction of every part and be able to put boxes and packing in repair when out of order. After using, clear water should always be run through the pump before it is put away.



AN AUTOMATIC AGITATOR.

One of the greatest obstacles to the successful use of fungicides and insecticides has been that of keeping the solid particles of the mixture in suspension so that a uniform quantity can be put on all parts of the trees or plants sprayed. To overcome this difficulty many appliances have been made to agitate the liquids so that these particles should not settle, and the improvements during the past season have been largely in the material of which the exposed parts of the pumps are made and appliances for keeping the solid particles of the spraying mixture in suspension.

We again present an agitator which has been found effective and easy of construction by any one accustomed to the use of ordinary tools and which is given to the public in the hope that it will make the results of spraying with the Bordeaux mixture and Paris green more uniform, safe and satisfactory.

This contrivance, shown at Fig. 1, is made for use with the barrel lying on its side, which we consider the best way to carry it, and consists of an arm (A) of flat iron one-eighth inch thick and seven-eighths inch wide, attached to the handle of the pump and entering the barrel about six or eight inches from its head. This arm is attached to an elbow (B), with arms six inches in length, which is fastened into a socket about four inches in length, that is bolted to the head of the barrel at (C). At the lower end of the elbow is attached a short arm (D), which is joined to the long arm that carries the dashers or agitators (E). This joint is necessary in order that the dashers may lie on the bottom of the barrel, and not be lifted up at every stroke of the pump. With the movement of the pump handle, the dashers made of wood move backward and forward over the entire bottom of the barrel, thus keeping the liquid in constant motion. In order that the liquid that may have settled on the bottom may be stirred thoroughly before starting the pump, the arm (A) is fitted to the pump handle by a slot (F), so that it may be quickly slipped off and worked upward and downward a few times before beginning to pump. All the parts are made of flat iron one-eighth inch thick by three-fourths inch wide, and can be made by one having facilities for cutting such iron and drilling holes to fasten it together. The parts are held together by short stove bolts. The dashers are fastened to the rod by a screw passing through it.

In the adjustment of this apparatus to the barrel, the pump must be brought near enough to the end of the barrel to allow of the full sweep of the pump handle, and the rod (A) fixed to the handle so as to give a full sweep to the elbow (B) that the dashers may be carried forward and backward to their fullest extent. This agitator has been fully tested, and we feel that, if properly adjusted, it will be entirely satisfactory. No patent has been applied for on this appliance, though it originated with us, as we wish the fruit growers of the country to have the benefit of it.

SPRAYING CALENDAR FOR 1896.

APPLE.

1st* Spraying. Bordeaux mixture (A) thoroughly just before leaves unfold.

2d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 100 gallons just before the blossoms open.

3d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 100 gallons as soon as the petals have all fallen.

4th spraying. Bordeaux mixture (B) in from ten days to two weeks from last spraying.

5th spraying. Bordeaux mixture (B) in from two to four weeks according to the weather. If dry and cool, the longer period, but if moist and warm, the shorter time.

6th spraying. Ammoniacal Carbonate of Copper as the fruit approaches maturity if the weather should be warm and moist.

This treatment is for the destruction of the *codling moth*, *tent caterpillar*, *canker worm*, *apple* and *plum curculio*, the *apple scab* or *fusicladium* and the *leaf blight* or *cedar apple* fungus.

Under ordinary conditions the first four applications will be sufficient and where the canker worms and tent caterpillars are not abundant the second spraying may possibly be omitted.

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*In the first application before the leaves unfold it is found that the Bordeaux mixture will give better results than the simple solution of copper sulphate often recommended because it adheres better to the twigs and buds.

PEAR.

The 1st, 2d and 3d sprayings should be the same as for the apple.

4th spraying. Bordeaux mixture (B) in one to two weeks.

5th spraying. Ammoniacal Carbonate of Copper when the fruit is nearly grown.

This treatment is for the *codling moth*, the *pear scab* and *leaf* and *fire blight*.

For the *pear tree psylla* use for 1st spraying. Kerosene Emulsion (A) in April before the buds open.

2d spraying. Kerosene Emulsion (A) in from one to two weeks if the young insects begin to appear.

3d spraying. Kerosene Emulsion (B) in from one to two weeks and repeat until all the insects disappear.

PEACH.

1st spraying. Bordeaux mixture (A) thoroughly just before the flower buds open.

2d spraying. Bordeaux mixture (B) as soon as the petals have fallen.

3d spraying. Bordeaux mixture (B) in from two to four weeks.

This is for the *plum curculio*, the *leaf blight*, and the *brown fruit rot*.

In the first spraying let the branches be thoroughly covered, and omit the 3d and 4th if the foliage is injured by the 2d as it has been under some conditions.

PLUM.

1st spraying. Bordeaux mixture (A) thoroughly just before the flower buds begin to open.

2d spraying. Bordeaux mixture (A) thoroughly and Paris green, 1 lb. to 100 gallons, as soon as the petals have fallen.

3d spraying. Bordeaux mixture (B) and Paris green, 1 lb. to 150 gallons, in from five to seven days.

4th spraying. Ammoniacal Carbonate of Copper, as the fruit approaches maturity.

The above treatment is for the *plum curculio*, the *black knot*, the *brown rot* and *leaf blight*.

CHERRY.

For the *plum curculio*, *black knot*, *leaf blight*, and *brown rot*, spray as for the peach.

For the *black aphis* use the kerosene emulsion (A), after the 3d application of the Bordeaux mixture, throwing it with as much force as is possible in, among and under the curled leaves where this insect is found sheltered.

GRAPE.

1st spraying. Bordeaux mixture (A) thoroughly before the buds unfold.

2d spraying. Bordeaux mixture (A) and Paris green, 1 lb. to 100 gallons, just before the blossoms open.

3d spraying. Bordeaux mixture (A) and Paris green as soon as the grapes have set, i. e. in from five days to two weeks.

4th spraying. Bordeaux mixture (B) in from two to four weeks according to weather.

5th spraying. Ammoniacal Carbonate of Copper when the fruit is near the first stages of coloring.

This is for the *rose-bug*, *mildew* and *black rot*.

RASPBERRY AND BLACKBERRY.

1st spraying. Bordeaux mixture (A) thoroughly just before growth begins.

2d spraying. Bordeaux mixture (B) thoroughly as the first blossoms open.

3d spraying. Bordeaux mixture (B) thoroughly as soon as the fruit is gathered.

4th spraying. Bordeaux mixture (B) should the fall orange rust appear in from two to four weeks.

This treatment is for the *spring orange rust*, *fall orange rust*, *anthracnose* and *leaf blight*.

CURRANT.

1st spraying. Bordeaux mixture (A) thoroughly just before the buds begin to open.

2d spraying. Bordeaux mixture (B) thoroughly as soon as the fruit has set.

3d spraying. Bordeaux mixture (B) thoroughly as soon as the fruit has been gathered.

This is for the *leaf blight.*

The *currant worms* are best destroyed by using hellebore or pyrethrum in water, one tablespoonful to two gallons sprayed over the bushes, or by dusting them with the same while they are wet with rain or dew.

STRAWBERRY.

1st spraying. Bordeaux mixture (B) thoroughly and 1 lb. of Paris green to 100 gallons, as soon as growth begins.

2d spraying. Bordeaux mixture (B) thoroughly and Paris green, 1 lb. to 150 gallons, not later than the opening of the first flowers.

3d spraying. Bordeaux mixture (B) thoroughly as soon as the fruit is gathered, if the bed is to be fruited a second season.

This is for the *black paria* and *leaf blight.*

The *newly set fields* for next year's fruiting should be sprayed with the Bordeaux mixture as soon as set out and two or three times at intervals of from two to four weeks after they begin to make runners. If possible the leaves of the plants should be dipped in the Bordeaux mixture before planting.

POTATO.

1st spraying. Bordeaux mixture (A) thoroughly and Paris green, 1 lb. to 100 gallons as soon as the larvae of the potato beetle or the flea beetles appear.

2d spraying. Bordeaux mixture (B) thoroughly and Paris green, 1 lb. to 150 gallons whenever the insects demand attention.

3d spraying. Bordeaux mixture (B) thoroughly and Paris green, 1 lb. to 150 gallons should the insects appear in abundance.

For the *potato beetle*, the *flea beetle* and *potato blight* and *rot* the above treatment has been found very effective.

CELERY.

1st spraying. Bordeaux mixture (A) thoroughly when the plants are half grown in seed bed.

2d spraying. Bordeaux mixture (A) thoroughly just before the plants are set in the field or dip leaves in the mixture before planting.

3d spraying. Bordeaux mixture (B) thoroughly after plants get well established in the field.

4th spraying. Bordeaux mixture (B) thoroughly should the blight continue.

This is for the *celery rust* and *leaf blight.*

BLACK POPLAR TREES.

1st spraying. Bordeaux mixture (B) about July 1st.

2d spraying. Bordeaux mixture (B) in from two to four weeks according to the weather.

This is for the *leaf rust.*

ELM TREES.

1st spraying. Kerosene emulsion thoroughly before the leaves unfold, for elm scale insect.

2d spraying. Bordeaux mixture and Paris green as soon as the leaves are partly unfolded, for elm beetle.

3d spraying. Kerosene emulsion when the young elm scale insects begin to hatch out.

4th spraying. Paris green 1 lb to 200 gallons for larvae of elm beetle as soon as the eggs begin to hatch and at intervals of one week to ten days until all are destroyed.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 38.

1. General Discussion on Commercial Fertilizers.
2. Analyses of Fertilizing Materials sent on for examinatiom.
3. Observations regarding the composition of Paris Green.
4. Observations concerning the action of Muriate of Potash on the lime constitutents of the soil.

MARCH, 1896.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may reguest the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1896.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are:—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
George A. Billings, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Charles E. Tisdale,	*Assistant in Foods and Feeding.*
Charles A. King,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

I.

General Discussion on Commercial Fertilizers.

By C. A. Goessmann.

The present condition of the trade in Commercial Fertilizers offers exceptional advantages to provide efficient manures for the raising of farm and garden crops of every description congenial to soil and climate. The various essential articles of plant food are freely offered for sale in forms suitable to render the different kinds of the manurial refuse material of the farm in a higher degree fit to meet the special wants of the crops to be raised. Mixed fertilizers, designed to supply the essential articles of plant food with reference to the needs of special crops, and containing them in every conceivable proportion, are asking for the patronage of all parties interested in the raising of plants.

The general character of the manurial substances, simple and compound, presented in our markets has on the whole been improving from year to year, in regard to their chemical composition as well as their mechanical condition. This circumstance is no doubt largely due to the introduction of a well regulated sytem of collecting samples of commercial fertilizers in the general market for a chemical examination and subsequently publishing results obtained for the benefit of farmers and dealers.

As the physical conditions and chemical resources of soils on available plant food are known to differ widely even on the same farm no definite rule can be given for manuring farm lands beyond the advice to return to the soil those plant constituents which the crops raised during preceeding years have abstracted in an exceptionally large proportion, and which will be especially called for by the crops to be raised. To assist farmers in selecting their fertilizers with reference to the wants of the crops they wish to cultivate, the writer has for years published in his annual reports a compilation of the analyses of the farm and garden crops to serve as a guide to all interested in a rational mode of manuring or feeding plants. Copies of these compilations of analyses may be secured by asking for them at the office of the Hatch Experiment Station at Amherst, Mass.

The current market cost of the different brands of fertilizers does not represent, *their respective agricultural value*, *i. e.*, their crop-producing value. The general character of the soil, its mechanical and chemical condition, as well as the special requirement of the crop to be raised, have to be consulted, when choosing intelligently fertilizers for home consumption.

A judicious selection of fertilizers from among the various brands offered for patronage, requires in the main, two kinds of information, namely, we ought to feel confident that the brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost; and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be only either phosphoric acid or nitrogen or potash; in others, two of them; and in others again all three. A remunerative use of commercial fertilizers can only be secured by attending carefully to these considerations.

The practice of adding to the manurial refuse materials of the farm as stable manure, vegetable compost, etc., such single commercial manurial substances as will enrich them in the direction desirable for any particular crop to be raised, does not yet receive that degree of general attention,—which it deserves.—An addition of potash in the form of muriate or sulphate of potash, or of phosphoric acid in the form of fine ground bones or of Florida phosphate, etc. will in many instances not only improve their general fitness as complete manure,—but quite frequently permit a material reduction in the amount of barnyard manure ordinarily considered sufficient, to secure satisfactory results. The average barnyard manure contains a larger percentage of nitrogen, as compared with its potash and phosphoric acid than is generally considered economical. An addition of from fifty to one hundred pounds of muriate of potash or of one to two hundred pounds of fine ground natural phosphates (Florida or S. Carolina) or of both potash and phosphates per ton of barnyard manure would greatly increase its claim as an efficient and economical general fertilizer.

On valuation.—The market value of the higher grades of agricultural chemicals and compound fertilizers depends in the majority of cases on the amount and the particular form of three essential articles of plant food they contain, i. e. nitrogen, potash and phosphoric acid. Supply and demand controls the temporary market prices not less in the fertilizer trade than in other lines of commercial business.

The approximate market value of a fertilizer, simple or compound, is obtained, by multiplying the pounds contained in a ton of two thousand pounds by the trade value per pound of each of the three above stated essential constituents of plant food present. The same course is adopted with reference to the different forms of each,—wherever different prices are recognized in the trade. Adding the different values—per ton,—obtained, we find the total value per ton at the principle place of distribution.

As farmers are frequently not in the position to secure the desired information regarding the legitimate market cost of the fertilizers, they wish to secure, the official inspectors of commercial fertilizers have aided them for years to ascertain the conditions of the fertilizer trade, with reference to current market prices of the leading or standard raw materials, as

Sulphate of Ammonia,
Nitrate of Soda,
Muriate of Potash,
Sulphate of Potash,
Dried Blood,
Dried Ground Meat,
Dry Ground Fish,
Azotin,
Ammonite,
Castor Pomace,
Bone and Tankage,
Plain Superphosphates, etc.,

which serve largely in the manufacture of good fertilizers for our market,—and have published the results of their inquiries in form of tables, stating the average trade values per pound for the preceeding six months, of the different kinds and forms of fertilizing materials at the leading places of distribution. The results of a recent meeting of the representatives of the Agricultural Experiment Stations of Connecticut, Rhode Island, New Jersey and Massachusetts are presented below :

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1896. *Cents per pound.*
Nitrogen in ammonia salts,	15.
“ “ nitrates,	13.5
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	14.
“ “ “ cotton-seed meal,	12.
“ “ “ fine ground bone and tankage,	13.5
“ “ “ fine ground medium bone and tankage,	12.
“ “ “ medium bone and tankage,	9.
“ “ “ coarse bone and tankage,	3.
“ “ “ hair, horn-shavings and coarse fish scraps,	3.
Phosphoric acid soluble in water,	5.5
“ “ soluble in ammonium citrate,	5.
“ “ in fine bone and tankage,	5.
“ “ in fine medium bone and tankage,	4.
“ “ in medium bone and tankage,	2.5
“ “ in coarse bone and tankage,	2.
“ “ in fine ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	4.5
“ “ insoluble (in am. cit.) in mixed fertilizers,	2.
Potash as High Grade Sulphate, and in mixtures free from Muriate,	5.
“ “ Muriate,	4.5
The manurial constituents contained in feedstuffs are valued as follows:	
Organic Nitrogen,	12.
Phosphoric acid,	4.5
Potash,	5.

The market value of low priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical condition for a speedy action, exert as a rule, a decided influence on their selling price.

The *mechanical condition of any fertilizing material*, simple or compound, deserves the most serious consideration of farmers, when articles of a similar chemical character are offered for their choice. The degree of pulverization controls almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant-food throughout the soil.

The *state of moisture* exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from 50 to 100 per cent in commercial value, on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Consumers of commercial manurial substances do well to buy whenever practicable, on guarantee of composition with reference to their essential constituents; and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent. Our present laws for the regulation of the trade in Commercial Fertilizers include not only the various brands of compound fertilizers, but also all materials single or compound without reference to source, used for manurial purposes when offered for sale in our market at ten dollars or more per ton.

A large percentage of commercial manurial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

An analysis of fertilizing materials at the station.—Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances—to be used for fertilizing purposes—coming through officers of agricultural societies and farmers' clubs within the State, will receive hereafter, as in the past, attention first, and in the order that applitions arrive at the office of the Station. The results will be returned without a charge for services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration, whenever the results promise to be of a more general interest. For obvious reasons no work can be carried on at the Station *free of charges* the results of which are not at the disposal of the managers for publication, if deemed advisable in the interest of the citizens of the State.

All parcels containing samples of Fertilizers for examination must have express charges prepaid ; they may be addressed to C. A. Goessmann, Hatch Experiment Station, Amherst, Mass. To avoid mistakes and delay, notice should also be given by postal card, that a package has been sent by express and the owners name should be stated inside or outside of the packages.

II.

ANALYSIS OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

101—104 COTTON SEED HULL ASHES.

I., II. and III. Sent on from Sunderland, Mass.
IV. and V. Sent on from Hatfield, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	12.66	12.40	5.29	15.40	16.32
Potassium oxide,	27.90	23.12	9.08	15.08	17.24
Phosphoric acid,	7.58	7.54	3.76	18.54	22.38
Insoluble matter,	3.80	5.08	35.47	21.34	16.29

105—108 COTTON SEED MEAL.

I. Sent on from Boston, Mass.
II. Sent on from Hatfield, Mass.
III. Sent on from Agawam, Mass.
IV. Sent on from Hatfield, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	7.03	6.57	6.00	5.97
Potassium oxide,	1.47	1.81	1.89	2.16
Phosphoric acid,	2.64	2.56	2.86	3.06
Nitrogen,	7.93	6.43	6.46	7.27

109—111.

I. Sent on from Hatfield. Mass.
II. Sent on from Springfield, Mass.
III. Sent on from Hatfield, Mass.
IV. Sent on from Hatfield, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	8.00	7.85	9.83	9.56
Potassium oxide,	1.58	1.36	1.74	1.58
Phosphoric acid,	1.96	1.24	2.45	2.23
Nitrogen,	3.48	2.05	5.20	4.25

The by-products of the cotton industry offered of late in our markets are of such a widely different general character, as well as different chemical composition, that special attention should be given to these points when deciding the market value of the various materials offered for sale.

112—113. LINSEED MEAL.

I. and II. Sent on from Agawam, Mass.

	Per Cent.	
	I.	*II.*
Moisture at 100° C.,	8.62	8.23
Potassium oxide,	1.26	1.23
Phosphoric acid,	1.87	1.80
Nitrogen,	6.35	6.33

114—116.

I. Dry ground bone, sent on from Wakefield, Mass.
II. Soft Florida phosphate, sent on from Hatfield, Mass.
III. Cremation ashes from refuse materials, sent on from Littleton Common, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	6.55	.82	4.46
Phosphoric acid,	27.04	27.24	7.18
Potassium oxide,	—	—	1.20
Nitrogen,	1.37	—	—
Insoluble matter,	—	22.37	47.51

117—119.

I. Cotton dirt, sent on from So. Dartmouth, Mass.
II. Card waste, sent on from West Rutland, Mass.
III. Soft coal ashes, sent on from Westfield, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.	30.90	58.50	.15
Potassium oxide,	.72	1.44	.16
Phosphoric acid,	.44	trace.	.45
Nitrogen,	1.07	4.84	—
Calcium oxide,	*	*	1.88
Insoluble matter,	36.99	3.39	79.85

120.

Liquid fertilizer (Ferti-flora) Senton from Wollaston Heights, Mass.

	Per Cent.
Moisture at 100° C.	83.75
Dry matter,	16.25
Phosphoric acid,	4.70
Potassium oxide,	2.77
Sulphuric acid,	2.39
Nitrogen,	1.47

The solution was offered for sale in bottles from 6 to 8 ounces capacity at 25 cents, from 2 to 3 cents representing the market value of the chemicals present. The composition is otherwise a good one for feeding plants within a limited supply of soil in the absence of any provision for drainage, if carefully diluted to one thousand pounds. Phosphate of Potash, Nitrate of Soda and Sulphate of Ammonia mixed in proper proportion will furnish a similar solution.

121—122. I. Sheep fertilizer. Sample collected at Boston, Mass'
II. Hen manure. Sent on from Hawley, Mass.

	Per Cent. I.	II
Moisture at 100° C.	11.54	11.31
Potassium oxide,	1.42	1.47
Phosphoric acid,	1.28	.76
Nitrogen,	2.38	.44
Insoluble matter,	*	71.07

*Not determined.

III.

OBSERVATIONS REGARDING THE COMPOSITION OF PARIS GREEN.

By C. A. Goessmann.

A. PARIS GREEN. *Common Brand.*

I. II. and III. From Amherst, Mass.
IV. From Boston, Mass.

	Per Cent. I.	II.	III.	IV.
Moisture at 100° C.	1.38	1.05	.67	1.20
Arsenious oxide,	54.85	54.14	53.73	56.04
Copper oxide,	32.55	31.05	30.60	32.30
Insoluble matter, in diluted hydro chloric acid,				.40

Calcium oxide, Magnesium oxide, Potassium oxide, Sodium oxide, Sulphuric acid, and Chlorine not present in appreciable quantities.

B. "THE LION BRAND NEW PROCESS PARIS GREEN."—

James Blanchard, Manufacturer.

V. and VI. From Amherst, Mass.
VII. and VIII. From Peabody, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	5.00	4.29	*	*
Arsenious oxide,	58.44	63.98	47.52	49.70
Copper oxide,	8.30	6.60	8.96	7.88
Calcium oxide,	14 50	15.98	15.67	16.88
Sulphuric acid,	7.56	5.80	7.47	5.78
Magnesium oxide,	.37	.56	1.15	1.37
Potassium oxide,	*	*	.04	.03
Sodium oxide,	*	*	3.23	2.36
Insoluble matter, in diluted hydro chloric acid	1.40	.60	*	*

* Not determined.

An examination of the above stated analyses shows a material difference in the composition of samples I., II., III., and IV. as compared with samples V., VI., VII., and VIII. The former, samples I. to IV., represent evidently the standard variety of Paris Green hitherto offered in our market; see compilation of analyses of Paris Green in my late annual report (1895). The samples V. to VIII. consist of a different article. A pound box containing the material was marked: "The Lion Brand New Process Paris Green" manufactured by James Blanchard, New York City, N. Y.; samples V. and VI. were bought last year and VII. and VIII. this year. The difference does not consist so much in the average amount of arsenious acid they contain, (from 54 to 55 per cent), as in the different percentage of copper oxide as well as the presence of a comparatively large amount of other constituents, as lime, magnesia, soda and sulphuric acid.

As the arsenious acid (white arsenic) is usually considered the principal acting poison in the Paris Green, it seemed of interest to make a few observations regarding the behavior of our different samples towards cold and hot water.

A.—One part of Paris green of samples I., II., III., IV., was treated with 100 parts of cold water each for three days at ordinary temperature. The resulting solution contained:

Arsenious acid,	3.62 per cent.
Arsenic acid.	None.
Copper oxide,	None.

One part of the same Paris green was treated with 100 parts of water at 80° C. for three hours and filtered while still hot. The solution tested without delay contained:

Arsenious oxide,	15.67 per cent.
Copper oxide,	None.

The same solution contained, after standing thirty-six hours:

Arsenious acid,	3.39 per cent.
Arsenic acid,	None.
Copper oxide,	None.

B.—Sample of "Lion Brand New Process Paris Green":

One part of samples VII. and VIII. was treated with one hundred parts of cold water each for three days. The solution contained:

Arsenious acid,	3.38 per cent.
Copper oxide,	None.

One part of samples VII. and VIII. was treated with one hundred parts of water each at 80° C. for three hours, filtered while still hot. —The resulting solution tested at once contained:

	VII.	*VIII.*
Arsenious acid,	24.12	15.92
Arsenic acid,	1.45	1.36
Copper oxide.	None.	None.

From these observations it will be noticed that the different samples tested by us contained on the average similar amounts of arsenious acid in their cold solutions. Observations concerning the action of dry Bordeaux mixture when added to either kind of our Paris greens for spraying purposes are under way and the results will be reported in one of our next bulletins.

An addition of one pound of common British gum (Dextrine) for every pound of Paris green used, holds, after drying, the latter in place:—

IV.

SOME OBSERVATIONS CONCERNING THE ACTION OF MURIATE OF POTASH ON THE LIME RESOURCES OF THE SOIL.

By C. A. Goessmann.

In connection with field experiments carried on for several years upon a field subdivided into eleven distinct plats, it was noticed that upon some of the plats the annual yield decreased, while upon others but little change could be observed. The young growth upon the affected plats showed a lighter color and was on the whole less vigorous than elsewhere upon the plats.

The field in question covers an area of nearly one and one-half acres and is subdivided, as stated, into eleven plats one-tenth of one acre each of uniform size and shape. A space of five feet in width separates the adjoining plats from each other. These spaces were neither manured nor seeded down. They were kept free from weeds by means of a cultivator. The ground is nearly on a level. The soil consists of a somewhat sandy loam from three to four feet in thickness. Through the center of each plat was laid a line of drain tiles at a depth of from three to four feet terminating in a bricked and cemented well to permit a collection of the drainage waters, if desired, from each plat before they reached the main drain. The entire field is surrounded by a layer of drain tiles to protect it against an access of the drainage from adjoining fields.

The fertilizers used upon the different plats have been for several succeeding years essentially the same in case of each plat, varying merely in regard to the quantities of the same ingredients used. One plat was manured with stable manure of known composition, the remainder received their phosphoric acid supply in the form of dissolved bone black. Some plats received their potash in the form of muriate of potash while others obtained it in form of potash-magnesia sulphate. The nitrogen supply consisted in case of some plats of nitrate of soda, in others of sulphate of ammonia or dried blood. Three plats did not receive nitrogen in any form in their fertilizer. One hundred and twenty pounds of potassium oxide, eighty pounds of available phosphoric acid and forty-five pounds of nitrogen per acre represent the amounts of essential articles of plant food used. Oats, rye, sojabeans, oats and sojabeans were the crops raised during the time of observation.

The unhealthy appearance of the crop was first noticed upon a plat which for several years in succession had been fertilized with a mixture of dissolved bone black, sulphate of ammonia and muriate of potash, and became subsequently noticeable more or less upon all plats which have received their potash supply in form of muriate of potash.

Being aware of the fact, that common salt and muriate of potash (chloride of sodium and chloride of potassium) under favorable conditions are decomposed by the carbonates of lime and magnesia of the soil, changing the latter from a comparatively insoluble form into a very soluble one (chlorides of calcium and magnesium) and thus becoming in an exceptional degree liable to be carried off by percolating waters, it seemed of interest to ascertain whether a deficiency of lime and magnesia was the cause of unsatisfactory crops. To secure this end the following course was adopted:

The plat which had first shown indications of an unsatisfactory condition of the soil was treated with a direct application of slacked lime, from 500 to 600 pounds per acre. The lime was applied broadcast early in the spring and subsequently ploughed under before preparing the soil for manuring and seeding. The succeeding crops of oats, looked healthy from the beginning to the end of the season.

The drainage water coming from each plat was collected, at the first running, after a severe rainstorm towards the close of the season. The analyses of the saline residue left by the evaporation of the drainage water coming from the different plats, showed in every case where muriate of potash had been used as the source of potash supply, a larger percentage of lime than in the case where sulphate of potash had furnished the potash in the fertilizer used. A special test for chloride of lime proved the presence of a liberal amount of that compound. Farther details are reserved for a future report.

The conclusions to be drawn from the above described observations are as follows:

a. The claim of both muriate and sulphate of potash, being economical and efficient forms to supply potash for growing plants is so well established that no farther endorsement is called for in this connection. Each form has its special merits with reference to particular fitness in case of different crops.

b. The liberal use of muriate of potash as a fertilizer constituent, renders, in cases where the lime resources of the soil under cultivation are limited, a periodical direct application of lime compounds as a manurial matter, advisable.

c. Muriate of potash is a safer source of potash for manurial purposes upon a deep soil with a free subsoil, than upon a shallow soil with a compact clayish subsoil, on account of a possible accumulation of the highly objectionable chlorides of lime and magnesia near the roots of the plants; both are known to prevent a healthy development of the root system.

Amherst, Mass., March, 1896.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS
AGRICULTURAL COLLEGE.

BULLETIN NO. 39.

ECONOMIC FEEDING OF MILCH COWS.

APRIL, 1896.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1896.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are:—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
George A. Billings, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Charles E. Tisdale,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

DIVISION OF FOODS AND FEEDING.

JOSEPH B. LINDSEY.

ECONOMIC FEEDING OF MILCH COWS.

(a) Principles of Nutrition.
(b) Feeds and Feed Combinations.
(c) Composition of Milk.

(a) PRINCIPLES OF NUTRITION.

In order to feed farm live stock to the best advantage, it is important that the feeder be familiar with some of the general principles of animal nutrition.

COMPOSITION OF THE ANIMAL BODY.

The body of the animal can be divided into four groups of substances namely, water, ash, flesh and fat.

Water: The entire animal body is largely composed of water. The new born calf contains 80 to 85 per cent; during the process of growth it decreases to 60 per cent while in the mature and moderately fat steer, water comprises only about 40 to 50 per cent of the entire body.

Ash: The mineral matter or ash exists largely in the bones, though small quantities are found distributed through all animal flesh. The bones are made up partly of ash, partly of fatty substances and partly of nitrogenous matter, such as glue, gelatine, etc. The mineral matter of the body in round numbers is:

In cattle, 4 to 5 per cent of the live weight.
" sheep, 2.8 to 3.5 " " " " "
" pigs, 1.8 to 3.0 " " " " "

About $\frac{4}{5}$ of the total is composed of phosphate of lime, and the remaining $\frac{1}{5}$ of soda, potash, magnesia, iron, chlorine and sulphuric acid.

Flesh: The flesh, or nitrogenous matter of the body is composed of two distinct groups of substances, the *albuminoids*, and *gelatinoids*.

The *albuminoids* are the more important, and are subdivided into albumen (represented in white of egg) which predominates in all animal fluids, flesh fibrin (myosin) or lean meat, and casein, the latter existing in quantity in the milk. The *gelatinoids* form the nitrogenous substances of the bone, cartilage, tendons and ligaments.

Horny matter is also a nitrogenous substance, differing in structure, but containing fully as much nitrogen as the albuminoids. The elementary composition of the several groups of fleshy substances is as follows:

Carbon,	52 to 54	per cent
Hydrogen,	7	"
Nitrogen,	15 to 17	"
Oxygen,	21 to 24	"
Sulphur,	1 to 1.5	"

The characteristic element is the nitrogen.

Fat: It is chiefly enclosed in special cells or tissues under the skin, between the bundles of muscular fibres, and in the kidneys. Its elementary composition is

Carbon	76.5	per cent
Hydrogen,	12.0	"
Oxygen,	11.5	"

If we should take the average of results obtained by experiments with various farm animals it might be said that the body of the animal has the following composition:

Bones,	8.9	per cent
Flesh and sinews,	40.1	"
Fat (by mechanical separation),	23.9	"
Residue,	27.1	"
	100.0	"

The residue represents the skin, hair, offal, blood and the contents of stomach and intestines. These various substances making up the animal body, are formed, with the aid of the oxygen of the air from the materials termed feeds, which the animals of the farm have the power of converting into energy, flesh, fat, bone and milk.

COMPOSITION OF PLANTS.

Recognizing the several groups of substances making up the animal body, let us turn our attention to the composition of the various cattle feeds that are transformed into beef, milk and pork.

They are composed of six distinct groups of substances: water, ash, cellulose, fat, protein and non-nitrogenous extract matter.

Water: The various green fodders, contain from 75 to 85 per cent of water, the hays and straws 12 to 16 per cent, and the different by-products and grains from 8 to 15 per cent.

Crude Ash is the mineral ingredient of the plant or seed. It will remain behind as ashes should the plant be burned. These ashes consist of lime, potash, soda, magnesia, iron, phosphoric acid and sulphuric acid.

Crude Cellulose: This is the coarse or woody part of the plant. It may be called the plant's framework. It composes fully one-third of the straws and hays, but is present only to a limited extent in the various grains. Cows, oxen and sheep have a digestive tract so arranged, as to be able to consume and digest large quantities of cellulose. Its elementary composition is carbon, oxygen and hydrogen.

Crude Fat: By crude fat is meant not only the various fats and oils found in different feeds, but also the waxes, coloring matter, etc. It has also been termed ether extract, because it represents that portion of the plant soluble in ether. In elementary composition it corresponds to animal fat.

Crude Protein: This is a general name for all the nitrogenous matters of the plant. It corresponds to the lean meat in the animal, and might be termed "vegetable meat." It has the same elementary composition as animal flesh and other things being equal it is the most valuable part of the plant.

Extract matter: It consists of sugar, starch and gums, and is made up of carbon, hydrogen and oxygen.

Carbohydrates: The cellulose and the extract matter have practically the same function as sources of nutrition, and collectively they are termed carbohydrates.

The Ash while a necessary ingredient of all feeds is so generally present as not to require any special consideration, so that in compounding fodder rations we really have to do with only three groups, *Protein*, *Fat* and *Carbohydrates*.

Nutritive Ratio: The numerical relation which the protein of a feed or feed combination bears to the carbohydrates (and fat reduced to carbohydrates) is termed its *nutritive ratio*. Fat is multiplied by 2½ to convert it into carbohydrates, because it furnishes 2½ times as much heat as the latter. If a ton of hay contains 96 lbs. digestible protein, and 928 lbs. digestible carbohydrates, it would have 9.4 times as much carbohydrates as protein or 1 : 9.4 which is its nutritive ratio.

DIGESTION.

What digestion is : Digestion is the changing of feeds in the stomach and intestines into soluble and diffusible substances, that can be taken up by the blood. The process briefly stated, is as follows : The feed is chewed in the mouth, and thoroughly moistened by the saliva. The moistening of the feed thus enabling it to be easily swallowed—is the principal value of this secretion. The stomach of the ruminant has four divisions. The slightly chewed feed passes to the large first stomach or paunch, and then into the smaller second division. The food, thus softened, is returned from the second stomach to the mouth and more thoroughly masticated and then passes to the third stomach. This third stomach has numerous folds, between which the food is pressed, and the soluble portions directly resorbed. It then passes into the fourth stomach where the ordinary process of digestion begins in the same manner as in animals having a simple stomach. The feed is here subjected to considerable motion and is acted on by the so-called gastric juice, the active principles of which are pepsin and hydrochloric acid. This action of these substances changes the protein into a soluble form called peptone. Neither the fat nor the carbohydrates undergo any change in the stomach.

Small amounts of some kinds of protein are so changed in the stomach as to be taken directly into the blood. But by far the larger part of the food now termed chyme, goes from the stomach into the intestines, to be further acted upon. The digestive fluids of the intestines are the bile or gall of the liver, the pancreatic juice of the pancreas, and the intestinal juice. The chief use of the gall is to divide the fat into very minute globules i. e. to emulsify it. The bile also aids in the resorption of the fat. The pancreatic juice contains a ferment called trypsin which acts powerfully upon the various forms of protein, changing any that escape the action of the pepsin of the stomach, into peptone, and still further converting a part of the peptone into other simpler substances. Another, no less important ferment is the ptyalin, which converts a considerable part of the starch and similar carbohydrates into sugar (maltose). The pancreatic secretion also acts in the same way as does the bile of the liver upon the fat, bringing it into a very finely divided condition.

The action of the intestinal secretion is not fully understood. It contains however a small amount of ptyalin which changes starchy matters into sugar.

In addition to the several secretions mentioned, various bacteria play a considerable part in the process of digestion in the small intestine. They decompose or break down more or less protein, convert starch into sugar, and decompose the cellulose which hitherto has not been acted upon, into a variety of simpler substances.

To recapitulate briefly: The food acted upon by the various secretions of the stomach and intestines as well as by bacteria is converted into soluble substances. This rather thick liquid has a milky appearance and is termed chyle. The food in this soluble condition is taken up by a multitude of so called epithelial cells or villi, with which the intestines are lined, and carried with more or less change into the blood, there to serve as a source of nourishment. That portion of the feed which has not been made soluble, passes on into the large intestine, and is finally excreted as faeces*.

WAYS IN WHICH THE DIFFERENT GROUPS OF DIGESTED FEED CONSTITUENTS ARE USED.

After the protein, carbohydrates, and fat, have been made soluble and taken into the blood, they are transported to the multitude of cells composing the body. The vital force of the cell—the cell juice or protoplasm—shatters or breaks the larger part of them into simpler substances thus liberating heat and vital energy. This process is completed by the oxygen of the blood still further decomposing them into carbonic acid and water, which are transported to the lungs and exhaled. *All three groups then, serve as sources of heat and energy.*

Special uses and characteristics of the protein: Protein is perhaps a source of fat, and *is the only source of flesh.* It is also—in the form of casein or curd—a very prominent constituent of milk. Before it becomes flesh or casein it is more or less reconstructed by the cells. When protein is broken up and transformed into heat and energy, a considerable portion of its carbon and hydrogen is exhaled by the lungs as water and carbonic acid. With its characteristic element—the nitrogen—this is not possible. The nitrogen is transformed into urea, and being of no further use is carried by the blood to the kidneys and excreted as a prominent constituent of the urine*. Experiments have proved that the more protein an animal consumes, the more will be decomposed and changed into heat; in other words, the quantity of protein consumed, governs the quantity destroyed. At the same time the more protein fed up to a certain point, the greater will be the tendency of the animal to put on flesh or produce milk. Too large an amount of protein cannot be fed, because herbivorous animals are not able to digest and assimilate it; even if this were possible it would not be economical, the protein being the most costly of the three groups. The animal must have a certain amount of feed to produce heat and energy, and this can be more cheaply secured from the carbohydrates.

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*The faeces or solid excrement, is nothing more than the undigested part of the feed. It contains one-half of the nitrogen, and three-fourths of the phosphoric acid excreted by the animal daily.

Protein *is necessary* to replace the wastes of the body, to form flesh, and to enable milk producing animals to give maximum and continuous milk yields.

Special use of the carbohydrates: The carbohydrates besides being the *principal source* of heat and energy, serve as the chief source of fat.

Special use of the fat: Experiments have proved that fat yields two and one-half times as much heat as the carbohydrates. Animal fat is also formed from the fat of the feed, but as a rule not directly; i. e. the fat molecule is more or less pulled to pieces, and reconstructed.

The lives of none of our farm animals can be sustained by protein, fat, carbohydrates or ash alone; and yet protein, carbohydrates and ash of the feed are all absolutely necessary to sustain life and produce growth. Experiments proving the above facts, teach us that for the securing of specific ends, such as the production of flesh, fat or milk, these several groups of substances as found in our various agricultural plants should not for economical reasons be fed at hap-hazard, but rather in reasonably definite proportions, depending upon the end sought

Digestibility of Feeds: Our observations concerning digestion make it clear that a feed is valuable as a source of nourishment, only so far as its various constituents can be digested and assimilated.

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*The urine or liquid excretion contains from 95 to 98 per cent of water. In solution are urea, potash, small quantities of lime, phosphoric acid, and other more complicated substances. The urine contains the most valuable half of the total nitrogen, (for fertilizing purposes) nearly all of the potash, and one-fourth of the phosphoric acid, excreted by the animal daily.

ILLUSTRATION FROM ACTUAL EXPERIMENT.

	100 lbs. Timothy Hay contains:			100 lbs. Swamp or Swale Hay contains;		
	Composition. Pounds.	Per cent Digestible.	Pounds Digestible.	Composition. Pounds.	Per cent Digesttible.	Pounds Digestible.
Water,	15.00	—		15.00	—	
Crude Ash,	4.30	—		5.20	—	
Crude Cellulose,	28.40	58	16.47	26.40	33	8.71
Crude Fat,	2.40	61	1.46	1.60	44	0.70
Crude Protein,	6.30	48	3.02	6.80	34	2.31
Extract Matter,	43.60	63	27.46	45.00	46	20.70
Total,	100.00		48.41	100.00		32.42

While these two hays approach each other very closely in composition, the Timothy proves to be much more digestible, and consequently the more valuable as a source of nourishment.

In order to ascertain the digestible matter in a cattle feed, it is necessary to know the amount and composition of the feed that is consumed by an animal in a given length of time, and also the amount and composition of the solid manure or undigested portion excreted in the same time. The difference between the amounts of the different groups consumed, and the different groups undigested, will give the amounts digested. The *percentages* of the groups digested are called digestion coefficients.

DIGESTIBLE NUTRIENTS NEEDED BY THE DAIRY COW.

A great many experiments have been made, principally by German investigators, to ascertain the most suitable quantities of digestible protein, carbohydrates, and fat, to be fed to milch cows daily in order to secure the best results. Emil von Wolff an investigator himself and also a close student of all experiments made along this line, has expressed it as his belief that average milch cows of 1000 lbs. live weight, need the following quantities daily.

Digestible:	Protein,	Fat,	*Carbohydates*,	Total.
Pounds:	2.50	0.50	13.00	16.00

Cows need approximately 16 pounds of total nutrients daily. Animals that are very thin in flesh, especially when fresh in milk can consume two pounds more to advantage. Of these 16 pounds, 2.50 pounds of digestible protein are necessary, in order to enable the cow to produce large and continuous milk yields. According to Wolff, if much less than 2.50 pounds daily are fed, the cow will shrink more rapidly in her yield. The quantity of fat is not of so much consequence, the 0.50 pounds being the amount that happened to result from the feed combination necessary to secure the protein and carbohydrates. These quantities of the several nutrients give a proportion of protein to carbohydrates or a nutritive ratio of 1 to 5.4. In other words, for milk production, animals need about five times as much carbohydrates as protein. These proportions cannot of course be followed with mathematical accuracy. Cows differ in their ability to turn feeds to the best account, and the judgment of an experienced feeder is always necessary if the best results are to be obtained. In all feed combinations palatability must also be carefully considered.

If a cow should be fed all she would consume of any palatable dry coarse fodder such as a good quality of hay, she would have at her disposal the following digestible nutrients :

	Protein.	Fat,	Carbohydrate.	Total,	Nutritive Ratio,
Pounds	1.4	0.4	12.4	14.2	1 : 9.5

It is very clear that such a ration lacks in protein, as well as in total digestible matter. In order to overcome these deficiencies, recourse is had to the concentrated feeds rich in protein. and sufficient are added to increase the protein to the necessary amount. By this addition of concentrated feeds, the necessary total nutrients will also be obtained. The protein is the most costly of the three groups of nutrients. The writer is not sure that it would be economy in all cases to feed 2.50 pounds. It is possible that the conditions in many cases are such that two pounds daily would be more economical. In other cases it might be wise to feed as high as three pounds daily. These problems are soon to be investigated.

(b) FEEDS AND FEED COMBINATIONS FOR THE DAIRY COW.

Having briefly considered the principles on which a rational system of animal nutrition is based, the next step is to classify the many different cattle feeds and consider their comparative values.

TABLE I.

CLASSIFICATION OF CATTLE FEEDS.

COARSE FEEDS.			CONCENTRATED FEEDS.	
1.	2.	3.	4.	5.
Low in Protein High in Carbohydrates. 50 to 65% digestible.	Medium in Protein. Medium in Carbohydrates. 55 to 65% digestible.	Low in Protein High in Carbohydrates. 85 to 95% digestible.	Low in Protein High in Carbohydrates. 80 to 90% digestible.	High in Protein. Medium in Carbohydrates. 80 to 90% digestible.
Hays, Straws, Corn Fodder, Corn Stover and Ensilage.	Clovers, Vetches, Pea and Bean Fodders and Brans	Carrots, Potatoes, Sugar Beets, Mangolds, Turnips.	Wheat, Rye, Barley, Oats, Indian Corn.	Bean and Pea Meals, Gluten Feeds and Meals, Linseed Meals and Cotton Seed Meal.

TABLE II.

EXAMPLES OF COMPOSITION.

Figures = percentage or pounds per hundred.

	Water.	Protein.	Fat.	Carbohydrates.	Nutritive ratio of Digestible Matter.	Comparative value of nitrogen, phosphoric acid and potash from one ton of several feeds.
Hay,	15.00	8.00	2.4	69.10	1 : 9.4	1.00†
Clover,	15.00	14.20	2.2	58.50	1 : 4.3	1.67
Mangolds,*	15.00	8.10	0.8	67.50	1 : 10.0	.18**
Corn Meal,	15.00	9.30	3.3	71.00	1 : 13.0	.94
Cotton Seed Meal,	15.00	38.50	9.9	24.00	1 : 1.1	3.86

Below 12 per cent may be termed low protein, from 12 to 20 per cent medium protein, and above 20 high protein. If we notice table two, we shall see that hay is low in protein, and this applies equally well to all coarse fodders excepting the legumes and brans.

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*For the sake of comparison, the analysis of mangolds is reckoned to 15 per cent of water. In their natural condition they contain 88 per cent. It would take about seven tons mangolds with natural amount of water to equal one ton with 15 parts water.

** In one ton mangolds with natural per cent water (88).

†These figures do not mean dollars and cents bnt simply express relative values.

These latter are medium in protein, having from 14 per cent in case of clover to 18 per cent in the bran. Corn meal is also low in protein, and the other grains but little higher. The grains have the *same type of composition* as do the hays and straws with this exception, that they contain little or no cellulose and hence are very much more digestible. The grains might be considered as concentrated hays, having one-third more nutritious matter than the latter. Other things being equal therefore, if a ton of hay was worth $15.00, a ton of corn meal would be worth $20.00 for feeding. The hays, roots and grains contain from nine to thirteen times as much carbohydrates as protein and are said to have a wide nutritive ratio. The legumes (clover, pea and bean fodders) contain more protein than do the hays and grains, having only about five times as much carbohydrates as protein and are said tc have a narrow nutritive ratio. The legumes are especially valuable as fodder crops because they are richer in the costly protein than the straws, grasses and grains, and because when supplied with but little nitrogen in the form of manure, they are able to take it from the air. They are also valuable to plant in rotation with grain crops and grasses.

In column five of Table I are classified those feeds high in protein. They are mostly by-products and vary from 20 per cent protein with a nutritive ratio of 1 : 3 in case of the gluten feeds, to 40 per cent protein with a ratio of 1 : 1.

We have then practically three classes of cattle feeds, (a) those low in protein and high in carbohydrates (1 : 10) such as hays, straws, roots and grains, but varying in digestibility, (b) medium in protein and medium in carbohydrates (1 : 5), and (c) high in protein and low in carbohydrates (1 : 2). Recognizing then the difference in composition of the various feed stuffs, and knowing the uses of the protein, fat and carbohydrates in the process of nutrition, our next step would be to so combine the several feeds as to secure the several groups in such quantities and proportions, as to best attain the end sought.

It might be of interest in passing, to note the comparative difference in the value of the nitrogen, potash and phosphoric acid in one ton of these several feeds. (See last column Table II.) The fertilizing ingredients in hays, straws, etc., have about the same value as in the grains. In the legumes they are one half as valuable again, and in case of the concentrated feeds, from three to nearly four times as valuable as in either the grains, straws or hays.

Before attempting to bring the various feeds together into what is termed fodder rations, it will be of interest to consider more in detail the most valuable feeds for both winter and summer feeding.

SUMMER COARSE FEEDS.

Pasture grass is a perfect feed for the dairy cow, and when the animal can secure sufficient of it, without too great efforts, maximum milk yields may be expected. This however is rarely the case, and it very frequently becomes necessary to practice at least a partial system of soiling.

Rye sown the previous autumn is the earliest green feed to be had in the spring. It cannot be fed over 10 days as it grows rapidly woody.

Wheat can follow rye and can be fed green for 14 days. After cutting the rye and wheat the land can be planted to corn. Wheat can be followed by clover and grass, or by clover alone, sown the year previous. The first annual crops from which green feed can be secured are Canada peas and oats, or vetch and oats.

These should be sown as early as possible in the spring. The peas or vetch should be harrowed or lightly plowed in to a depth of three or four inches and the oats lightly harrowed in. Either combination makes a most excellent green feed and by planting several lots about two weeks apart, green feed can be secured during nearly the entire month of July. The vetch seed is rather more costly than the peas. The only objection to the Canada peas is their tendency to lodge. Some prefer the Champion of England or Black Eyed Marrowfat on this account. For green feed during the month of August the barnyard millet (Panicum crus galli) is to be recommended. This millet was imported from northern Japan. The wild species growing in this country is the common barnyard grass. The cultivated species grows upright from five to seven feet tall, and yields from 12 to 20 tons of green material per acre. Animals eat it with avidity. It also makes very good hay, but being coarser than the common millet there is difficulty in curing it. It needs plenty of moisture to produce maximum yields, and will not stand a drought as well as corn. Medium green soja beans, sown in drills two and one-half feet apart about May 20 will grow four feet tall, and furnish a green fodder rich in protein from Aug. 20 to Sept. 15.

Corn planted May 20 will furnish green fodder from Aug. 25 to Sept. 20. It can be feed in connection with soja beans one-half of each, to excellent advantage and furnishes a properly balanced ration. Land from which peas and oats have been removed by July 15, can be seeded at once with Hungarian grass and will yield green feed from Sept. 20 to Oct. 5; the balance if any can be made into hay. One can expect from one to one and one-half tons of hay per acre. Barley and peas sown Aug. 1–5 will furnish plenty of green feed during October. These last fodders will stand very severe frosts.

TABLE III.

SOILING CROPS.

(For 10 cows entire soiling.)

Kind.	Seed per Acre.	Time of Seeding	Area.	Time of Cutting.
Rye	2 bush.	Sept. 10-15	½ acre	May 20—May 30
Wheat	“	“	“	June 1 June 15
Red Clover	20 lbs.	July 15–Aug. 1	“	June 15—June 25
Grass and Clover	1-2 bu. redtop 1 peck timothy 10 lb. red clover	Sept.	⅔ acre	June 15—June 30
Vetch and Oats	3 bush. oats 50 lbs. vetch	April 20	½ acre	June 25—July 10
“ “ “	“ “	“ 30	“	July 10—July 20
Peas and Oats	1 1-2 bu. Canada 1 1-2 bu. oats	“ 20	“	June 25—July 10
“ “ “	“ “ “	“ 30	“	July 10—July 20
Barnyard Millet	1 peck	May 10	⅓ acre	July 25—Aug. 10
“ “	“	“ 25	“	Aug. 10—Aug. 20
Soja Bean (medium green)	18 quarts	“ 20	⅓ acre	Aug. 25—Sept. 15
Corn	—	“ 20	⅓ acre	Aug. 25—Sept. 10
“	—	“ 30	“	Sept. 10—Sept. 20
Hungarian	1 bush.	July 15	½ acre	Sept. 20—Sept. 30
Barley and Peas	1 1-2 bu. Peas 1 1-2 bu. Barley	Aug. 5.	1 acre	Oct. 1—Oct. 20

It is of course not expected that all farmers will find it necessary to use all of these crops, or to follow in the rotation above outlined. The area suggested for each crop is at best only an approximation. Farmers will in a large measure be obliged to use their own judgment, as much will depend on the season, condition of land and whether the crops are grown to help out the pasture or as an entire substitute.

Grass and clover or clover, and peas and oats or vetch and oats, as given in the above table are intended as alternate crops to be used according to choice.

WINTER COARSE FEEDS.

Among the most economical winter coarse feeds for dairy stock can be mentioned corn, barnyard millet, hay, and soja beans. On natural grass land not easily affected by droughts the farmer will naturally grow a considerable area of hay, and depend upon this crop to a large extent for coarse feed. Such land should be made to produce three tons of hay, equivalent to about three thousand pounds of digestible matter per acre. Similar land planted to corn and equally well manured would probably produce fully four thousand pounds digestible matter per acre, but the increased cost of growing an acre of corn would in the writer's judgment fully balance the increase in yield.

There are however considerable areas on every farm that are not natural grass lands. Such lands are so easily affected by frequent droughts, that from one to one and one-half tons of hay per acre are maximum crops. Land of this kind is far better suited for corn and will yield fully three times as much digestible matter per acre as when in grass.

Ensilage: Corn or any crop put in the silo is not improved in quality. The various fermentations which such materials undergo, decrease to an extent their nutritive effect, i. e. a ton of fodder before being ensilaged would have a greater nutritive value than after being ensilaged. The writer does not believe in putting any crop into the silo that can be properly cured. Unfortunately it is very difficult to cure Indian corn fodder. It is also difficult to cut or shred it and preserve it outside of the silo in quantity for any length of time. For these reasons, the silo all things considered is undoubtedly to be preferred for preserving the corn plant, and practical experience has demonstrated its value.

For those who desire corn meal during the winter for feeding horses, pigs, and poultry, it is a very good idea to remove the ears from the stalk just previous to cutting for ensilage. They can be thrown upon the ground and allowed to remain for about two weeks to cure, and can then be husked. If it was not for the increased labor involved in removing the ears and in husking and grinding the same, the writer would not advocate putting any of the grain into the silo, for it has been clearly shown that the loss during fermentation is considerable.

The medium green soja bean is a valuable crop to put into the silo with corn. The method of cultivation has already been described.

One part bean fodder and two parts corn fodder is a good proportion. It should not be put in in layers, but both corn and bean plants run through the cutting machine together. Thus mixed, the bean fodder will keep better, and will aid in neutralizing the acidity of the corn. The advantage of this mixture for feeding is, that it increases the percentage of protein in the ensilage from 1.4 or 1.6 per cent (corn alone) to 2.6 or 2.8 (mixed ensilage). If this mixture could be fed as an entire daily ration, but very little concentrated feeds, rich in protein, would be required. Corn for ensilage should be cut when the ears are fairly well glazed. Beans planted about May 25 will be ready at the same time. Barnyard millet is also recommended to be used in connection with sojo beans for the silo. It requires fully as much plant food to produce a crop, as does corn, and will not stand dry weather as well. On fairly moist land from 15 to 17 tons can be grown per acre. The seed can be sown broadcast, and the crop needs no further attention till cut with a mowing machine early in September for the silo, thus effecting a considerable saving of labor. Millet for ensilage should be planted about June 1.

The hay of vetch and oats, peas and oats, and of Hungarian grass makes good coarse feeds for winter, equal to an average quality of hay. The peas and oats can be cut when in blossom early in July and followed immediately by Hungarian grass. One is thus enabled to grow from three to three and one-half tons of these hays per acre. On lands that cannot be made to produce two and one-half tons of English hay yearly, this method might be followed with advantage, if labor is not too costly. By planting a variety of annual fodder crops, many farmers are so situated as to beable to sell English hay to advantage.

CONCENTRATED FEEDS.

Classification, showing comparative feeding value on bases of protein they contain, as well as comparative commercial and manurial values.

TABLE IV.

COMPARATIVE FEEDING VALUES.

Class I.	Class II.	Class III.	Class IV.
Cotton-seed Meal Gluten Meals Linseed Meals Atlas Meal	Gluten and Maize Feeds	Malt Sprouts Dry Brewers Grains Wheat Middlings and Brans*	Wheat Oats Corn Rye and Barley Meals

TABLE V.

	Comparative Commercial value Per Ton.		Comparative Manurial value.
Wheat Bran,	$18.00	$14.00	1.8
Corn Meal,	19.00	15.00	1.0
Wheat Middlings,	21.00	16.00	1.5
Brewers Grains,	21.00	16.00	1.5
Malt Sprouts,	23.00	18.00	2.1
Gluten and Maize Feeds,	28.00	22.00	1.8
Atlas Meal,	31.00	24.00	2.5
O. P. Linseed,	31.00	24.00	2.9
N. P. Linseed,	32.50	25.00	3.2
Gluten Meals,	35.00	27.00	2.9
Cotton Seed Meal,	35.00	27.00	3.6

EXPLANATION OF THE TABLE.

(a) Feeding values : As has already been stated the concentrated feeds are valuable chiefly in proportion to the protein they contain. An exception to this has already been alluded to in case of Class IV. This class has practically the type of composition of the various coarse fodders, differing in that they are nearly free from cellulose or fibre and consequently are much more digestible. They are therefore to be used more as producers of fat, heat and energy, than as *furnishers of protein.*

The concentrated feeds in the above table are divided into four different classes, depending on the quantity of protein they furnish. Those in Class I are highest; those standing first in their class are richest in protein, and those last poorest, etc. For practical purposes in combining the various concentrated feeds into rations, those in each class may be regarded as having equal *feeding* values, the market price governing the selection. Other things being equal however, those standing first in their class are to be preferred.

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*Bran strictly speaking is a coarse feed, being but 60 per cent digestible. As it is generally purchased and fed with concentrated feeds, it is also classified here.

(b) Commercial values: These values of the concentrated feeds do not express their physiological effects in the process of nutrition. The figures are intended primarily to show *comparative* commercial values, by figuring the digestible protein, carbohydrates and fat in each of the feeds, at similar prices per pound. They will be found very useful as guides in purchasing.

(c) Manurial values: The figures in this column are intended to show comparative values only, 1 being the poorest. It will thus be seen that cotton and linseed meals (i. e. those in Class I) furnish a manure from three to three and one-half times as valuable as does corn meal. The manurial values of the feeds can be arranged under the same classes as their feeding value, i. e. those having the most protein having greatest manurial value.

HOW TO COMBINE THE COARSE AND CONCENTRATED FEEDS, TO PRODUCE WELL BALANCED DAILY RATIONS.

For practical purposes it is not possible to weigh out the coarse feeds, and a great deal will have to be left to the judgment of the feeder. If hay alone is fed, give all the animal will eat up clean twice daily. One-third to one-fourth of the coarse fodders can consist of straw. It is hardly economical to feed over fifteen pounds of roots daily. From 30 to 35 pounds of ensilage daily is sufficient. More than this will disturb the digestion of some animals, and also make many cows lose in flesh. Nine to twelve pounds of hay or other coarse feed of a similar nature, together with 30 to 35 pounds of ensilage make sufficient coarse fodder for an animal's daily needs. It is not good economy to feed over one-half of any leguminous crop, either green or dry, in the total daily coarse fodder ration.

While the coarse feeds can be fed according to the feeders judgment observing the general rules given above, it becomes necessary both for the sake of economy and health, to weigh or carefully measure the grain ration. The coarse feed will furnish from 1.00 to 1.50 pounds of digestible protein and we add the concentrated feeds primarily to secure the extra 1.00 to 1.50 pounds of protein necessary, to properly balance the ration. The following grain mixtures will do this, and are intended to be fed in connection with coarse feeds, thus making properly balanced daily rations.

GRAIN MIXTURES FOR COWS OF 1000 POUNDS LIVE WEIGHT.

I.

100 lbs. Class I. *
100 “ “ II.
100 “ “ IV.
Mix and feed 5 to 7 quarts daily.

II.

100 lbs. Class I.
100 “ “ II.
100 “ “ III.
Mix and feed 7 to 9 quarts daily.

III.

100 lbs. Class II.
100 “ Atlas meal.
Mix and feed 5 to 7 quarts daily.

IV.

100 lbs. Class I.
100 “ “ IV.
Mix and feed 5 to 7 quarts daily.

V.

100 lbs. Class I.
150 “ “ III.
Mix and feed 6 to 8 quarts daily.

The above grain rations can be used as types, and the farmer can select the particular feeds in each class which are the cheapest. In case a grain mixture is composed of three concentrated feeds, see during the winter that not more than two of the feeds have a high fat percentage and in summer not more than one. In case two feeds only are employed in the mixture, but one of them should have a high fat percentage especially in summer. Those feeds especially rich in fat are cotton seed meal, King and cream gluten meals, Atlas gluten meal and the gluten feeds. Excess of fat, in summer especially, is very liable to produce inflammation of the udder.

The lesser amount of grain as specified above, fed together with the coarse feeds will furnish about two pounds of digestible protein daily and the larger amount two and one-half pounds. When cows derive part of their feed during the summer from pasture grass, and part from soiling crops, about one-half the quantity of the grain mixtures can often be fed to advantage. In case the soiling crops are made up of one-half leguminous fodder, no grain need be given. Should corn and soja bean ensilage or millet and bean ensilage be fed in place of clear corn ensilage, the grain ration can be reduced about one-third.

As the cow approaches the time of calving, the grain ration can be gradually reduced. The cow ought to go dry from 45 to 60 days. After the animal has been dried off, from two to three or even four quarts of the grain mixture can be fed if she is thin in flesh. This amount can be fed till within a week of calving.

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* See table IV, page 17.

When to feed and water: The writer is of the opinion that two feedings, morning and late afternoon, are sufficient daily. The animal thus fed is abundantly able to take all that is necessary for her welfare. The cow desires considerable time to remasticate her feed, and there can surely be no advantage in the midday feeding. Feeds that are liable to taint the milk, should be fed immediately after milking.

Cows should be watered twice daily if possible, namely after the morning and evening feeding. It is a great advantage to have the chill taken from the water in winter. The writer advocates the use of the self watering device whenever practicable in well ventilated barns. The animal is thus enabled to drink whenever she has the desire which is to her advantage.

(c) COMPOSITION OF MILK.

Average cows milk has the following composition:

Water,	87.00 per cent
Fat,	4.00 "
Casein and albumen (curd),	3.20 "
Milk sugar,	5.10 "
Ash,	0.70 "

Average composition of milk of different breeds:

	Total Solids.	*Fat.*	**Solids not Fat.*
Holstein,	11.8 per cent	3.2 per cent	8.6 per cent
Ayrshire,	12.5 "	3.7 "	8.8 "
Shorthorn,	12.9 "	3.8 "	9.1 "
Devon,	13.4 "	4.4 "	9.0 "
Jersey,	14.7 "	5.0 "	9.7 "
Guernsey,	14.7 "	5.0 "	9.7 "

While the above figures can be taken as types, they do not mean that every cow of a distinct breed will give milk of the above composition. In fact a great many Jerseys produce milk with four per cent of fat, and families and individual cows of the Holstein breed yield milk as rich as do many Jerseys or Guernseys.

EFFECT OF FEED UPON THE COMPOSITION OF MILK.

Feed has very little if any effect upon the quality of milk. By quality we refer to the per cent or amount of total solid matter in the milk. It is a well recognized fact that some feeds affect the flavor of milk and possibly to a slight extent its color. Feeds rich in protein have a tendency to *slightly* increase the percentage of fat in case of some cows: the same can be said of feeds rich in fat. This increase is probably only temporary however, the milk gradually coming back to its normal composition. Animals very thin in flesh, and insufficiently fed, if brought into good condition by proper feed will probably yield milk of rather better quality. The improvement in quality will not as a rule be very marked. The milk producing function is to a large extent under the control of the nervous system. Any influence that disturbs the quiet or normal condition of the animal, be it rough usage, extremes of temperature, exposure to rain, etc., will have its effect upon the quality of the milk. On the other hand, plenty of good feed increases the quantity of the milk until the animal reaches her maximum production. What has been said with regard to the influence of feed upon the quality of milk is equally true, relative to the amount of butter that can be made from a given quantity of milk. *No method of feeding* has as yet been discovered that so improves the quality of the milk, as to make a given quantity of milk produce more butter at one time than at another. The quality of milk varies during the different stages of lactation, but this is entirely independent of the influence of feed. The above statements are based on the teachings of carefully conducted experiments. They are contrary to the general belief that the better the animal is fed, the better the quality of the milk produced.

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*Containing milk sugar, curd and ash.

COMPOSITION, DIGESTIBILITY AND FERTILIZING CONSTITUENTS OF THE MOST IMPORTANT CATTLE FEEDS.

(Figures=percentages or pounds per 100.)

NAME.	Composition.							Digestibi'ty			Fert. Constituents.				
	Analyses.	Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Protein.	Fat.	Carbohydrates.	Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
I. Green Fodders.															
Fodder Corn,	33	75	1.2	5.2	.5	2.0	11.7	1.1	.4	11.4	14	79	.41	.33	.15
Pasture Grass,	-	80	2.0	4.0	.8	3.5	9.7	2.6	.5	10.6	-	-	-	-	-
Barnyard Millet (P. crus-galli),	2	73	2.1	7.6	.7	2.7	14.0	-	-	-	1	75	.46	.49	.11
Green Oats,	6	74	2.1	7.8	.8	3.6	11.7	2.5	.5	12.9	3	83	.49	.38	.13
Green Barley,	1	79	1.8	7.9	.6	2.7	7.9	1.8	.4	11.2	-	-	-	-	-
Green Rye,	2	72	1.6	8.9	.6	2.1	14.8	1.5	.4	15.8	2	72	.30	.64	.12
Hungarian Grass,	2	74	2.1	7.0	.5	2.6	13.6	1.6	.3	13.8	1	74	.39	.54	.16
Soja Bean,	14	75	2.5	6.5	1.1	4.2	10.2	2.9	.3	10.1	1	70	.84	.71	.20
Green Clover,	43	71	2.1	6.1	1.1	4.4	13.5	2.9	.7	14.1	-	71	.60	.20	.11
Alsike Clover (bloom),	4	75	2.0	7.4	.9	3.9	11.0	2.7	.6	13.1	-	82	.50	.20	.11
Corn Ensilage,	38	78	1.2	6.0	.8	1.9	11.8	.9	.6	12.0	7	80	.32	.39	.13
Corn and Soja Bean Ensilage,	3	76	2.6	7.3	.9	2.5	10.2	-	-	-	1	71	.40	.44	.42
Millet and Soja Bean Ensilage,	6	76	3.0	7.3	1.0	3.0	10.0	-	-	-	5	76	.48	.54	.12
Millet Ensilage,	3	74	2.4	7.5	.8	1.7	13.8	-	-	-	3	74	.26	.62	.14
II. Hay and Dry Coarse Fodders.															
English Hay, (mixed grasses),	60	14	5.4	26.7	2.4	8.1	43.1	4.8	1.1	41.4	12	12	1.32	1.55	.30
Timothy Hay,	6	14	4.2	28.3	1.9	8.5	44.1	4.1	1.1	42.5	3	12	1.24	1.46	.34
Rowen,	15	17	5.9	22.2	3.0	10.5	41.2	7.1	1.1	42.4	13	18	1.63	1.50	.44
Oat Hay (in bloom),	1	15	5.6	30.6	2.4	5.5	42.0	3.9	1.5	47.8	-	-	-	-	-
Barley Hay (in milk),	1	15	4.2	24.7	2.4	8.8	44.9	6.2	1.5	46.6	-	-	-	-	-
Dry Corn Stover,	30	20	4.7	28.3	1.1	5.9	40.4	3.1	.6	44.8	17	20	.90	1.25	.25
Red Clover,	2	15	7.7	26.0	2.2	12.7	36.7	8.3	1.1	41.0	2	10	2.2	2.30	.45
Alsike Clover,	6	15	9.9	22.3	2.2	14.1	36.5	8.7	1.1	37.5	6	10	2.3	2.20	.60
Vetch and Oats,	3	12	6.8	28.9	2.7	12.5	37.4	7.5	.5	39.3	3	10	1.3	1.3	.56
Wheat Straw,	1	15	4.1	30.4	1.3	6.2	43.0	1.1	.5	35.5					
Barley Straw,	2	15	4.8	32.2	2.5	6.5	40.0	1.3	1.0	36.7	2	10	1.1	2.4	.22
Barnyard Millet Straw,	1	13	4.7	31.4	2.1	5.3	43.9	-	-	-	1	13.5	.69	1.7	.18

NAME.	Composition.							Digestibility.			Fert. Constituents.				
	Analyses.	Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Protein.	Fat.	Carbohydrates.	Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
III. Roots.															
Sugar Beets,	12	85	.90	1.0	.1	1.6	11.0	1.1	.05	11.	4	87	.22	.48	.10
Mangolds,	5	88	1.2	.8	.1	1.4	8.6	1.1	-	7.8	3	88	.15	.34	.14
Ruta-bagas,	3	89	1.1	1.3	.2	1.2	7.1	1.0	.1	7.7	3	89	.19	.49	.12
Flat Turnips,	5	90	.9	1.2	.2	1.1	7.0	1.0	.2	8.0	4	90	.17	.38	.12
Potatoes,	14	81	1.0	.5	.1	1.9	15.5	.8	-	14.1	4	80	.29	.51	.08
IV. Grains and Seeds (ground).															
Corn Meal,	38	14	1.4	1.8	3.3	9.5	70.4	5.7	3.0	65.	13	11	1.8	.40	.70
Corn and Cob Meal,	37	11	1.4	6.7	3.7	9 0	68.7	5.4	4.2	62.7	29	9	1.4	.47	.60
Wheat Meal,	1	12	2	2.9	2.0	12.1	69.5	-	-	-	2	12	2.0	.36	.35
Ground Oats,	2	10	3.5	8 5	3.6	11.4	63.7	8.0	3.2	62.7	-	-	-	-	-
Ground Barley,	5	13	2.4	5.7	1.9	11.3	65.6	7.9	1.7	63.2	1	13	1.5	.34	.70
Soja bean Meal	1	11	4.1	3.7	16.3	34.4	30.9	31.3	14.0	26.1	1	11	5.9	2.2	1.6
V. By-products.															
Linseed Meal (new process),	8	8	5.9	8.5	2.9	36.1	37.3	30.7	2.7	38.4	5	8	5.8	12	1.8
Linseed Meal (old process),	8	10	6.2	7.8	6.6	33.1	36.6	29.5	5.9	33.0	4	8	5.4	1.2	1.8
Cotton-seed Meal,	32	8	6.9	6.6	10.7	41.6	25.9	36.6	10.0	18.7	24	8	6.7	1.8	2.5
Chicago Gluten Meal (old process),	3	9	.8	1.1	6.2	30.4	52.2	27.1	5.8	48.4	5	8	5.1	.05	.42
Chicago Gluten Meal (new process),	4	10	1.3	2.4	6.0	38.4	42.3	-	-	-	-	-	-	-	-
King Gluten Meal,	2	7	1.7	1.4	19.1	34 6	35.9	31.8	18.1	30 2	1	8	5.7	.08	.69
Atlas Gluten Meal,	2	10	1.1	11.1	12.8	34.3	30.8	25.0	12.9	31.9	1	11	5.3	.16	.23
Buffalo Gluten Feed,	15	8	.9	6.8	11.9	23.0	49.3	19.6	9.6	45.3	5	8	3.7	.06	.34
Peoria Gluten Feed,	4	7	1.2	7.6	12 4	20.5	51.1	17.0	9.8	52.0	-	-	-	-	-
Pope Gluten Feed,	2	9	1.1	6.2	8.3	24.4	50.5	-	-	-	-	-	-	-	-
Chicago Maize Feed,	5	8	.6	7.5	7.1	24.9	51.7	21.2	6.5	51.7	-	-	-	-	-
Wheat Bran,	49	11	6.8	9 8	4.5	16.1	52.2	12.5	3.2	38.2	10	11	2.4	1.4	2.1
Wheat Middlings,	9	10	5.1	6.8	4.8	15.7	57.3	13.1	4.1	52.8	2	10	2.7	.75	1.2
Dry Brewers Grain,	4	10	4.1	10.2	4.4	21.0	50.4	16.6	4.0	45.1	2	9	2.7	.85	1.0
Malt Sprouts,	5	10	5.9	11.0	1.7	24.8	47.0	19.8	1.7	36.2	-	-	-	-	-
Oat Feed,	10	7.5	4.9	13.0	4.3	11.8	58.5	-	-	-	-	-	-	-	-

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 40.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

II. ANALYSES OF LICENSED FERLILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1896.

JULY, 1896.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1896.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
George A. Billings, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Charles E. Tisdale,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

DEPARTMENT OF CHEMISTRY.

C. A. GOESSMANN.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

SULPHATE OF POTASH.

123-126. I. Received from Berlin, Mass.
II. and III. Received from Southwick, Mass.
IV. Received from Conway, Mass.

	Per cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	.47	.95	.50	5.87
Potassium oxide,	48.40	49.80	47.40	27.90

127-130. I. Received from Conway, Mass.
II. Received from So. Berlin, Mass.
III. Received from Marlborough, Mass.
IV. Received from So. Hadley, Mass.

	Per cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	2.98	.28	.34	.36
Potassium oxide.	25·42	47.85	50.48	46.90

MURIATE OF POTASH.

131-132. I. Received from Hudson, Mass.
II Received from So. Hadley Falls, Mass.

	Per cent.	
	I.	II.
Moisture at 100° C.,	.35	.93
Potassium oxide,	50.32	50.50

WOOD ASHES.

133-137. I. Received from Amesbury, Mass.
II. Received from Wollaston Heights, Mass.
III. Received from Boston, Mass.
IV. Received from Lowell, Mass.
V. Received from Sudbury, Mass.

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	9.14	23.31	1.55	2.38	9.20
Potassium oxide,	5.08	4.48	5.04	3.44	4.00
Phosphoric acid,	1.38	1.18	1.16	.90	1.22
Calcium oxide,	38.13	29.00	32.02	29.86	36·21
Insoluble matter,	9.03	11.51	27.54	22.83	22.48

WOOD ASHES.

138-142. I. Received from Winchester, Mass.
II. Received from Amesbury, Mass.
III. Received from Fitchburg, Mass.*
IV. Received from Concord, Mass.
V. Received from Hatfield, Mass.

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	1.27	3.91	.77	10.58	1.31
Potassium oxide,	5.16	6.20	.54	6.42	8.10
Phosphoric acid,	.98	1.90	.51	1.22	1.41
Calcium oxide,	28.25	19.94	2.22	36.12	27.80
Insoluble matter,	21.35	32.81	81.04	9.10	31.79

142-147. I, II and III. Received from Concord, Mass.
IV. Received from No. Hatfield, Mass.
V. Received from Worcester, Mass.**

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	6.92	9.40	13.97	1.51	10.29
Potassium oxide,	6.52	6.52	7.08	6.62	2.96
Phosphoric acid,	1.54	1.41	1.47	1.02	.72
Calcium oxide,	33.90	35.08	31.92	†	†
Insoluble matter,	13.65	10.86	8.73	11.88	12.38

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*This sample is evidently not wood ashes.

**Partly leached ashes.

†Not determined.

148-152. I. Received from Hudson, Mass.
II. Received from Concord, Mass.
III. Received from Fitchburg, Mass.
IV. Received from Lexington, Mass.
V. Received from Amherst, Mass.

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	18.18	10.72	.47	7.20	10.65
Potassium oxide,	7.36	6.16	4.16	5.90	6.47
Phosphoric acid,	1.02	1.66	1.28	1.66	1.40
Insoluble matter,	5.43	*	*	11.68	8.42

153-157. I. Received from No. Hatfield, Mass.
II. Received from Whately, Mass.
III. Received from So. Sudbury, Mass.
IV, V. Received from Mt. Lebanon, N. Y.

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	11.11	6.20	4.53	2.92	4.20
Potassium oxide,	3.52	5.76	5.88	6.22	8.40
Phosphoric acid,	1.44	1.46	1.77	1.65	1.85

158-162. I, II, III, IV, V. Received from Concord, Mass.

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.01	6.19	11.83	10.25	11.05
Potassium oxide,	5.64	4.72	8.08	3.92	3.56
Phosphoric acid,	1.52	1.63	1.40	1.50	1.55
Insoluble matter,	10.12	16.44	*	14.96	14.06

163-167. I. Received from Amherst, Mass.
II. Received from Arlington, Mass.
III. Received from East Northfield, Mass.
IV, V. Received from Ashland, Mass.

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	5·20	4.07	8.65	6.35	8.12
Potassium oxide,	6.24	6.48	5.92	5.22	4.94
Phosphoric acid,	1.67	1.55	1.65	.95	1.05

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*Not determined.

168-169. I. Wood ashes received from Sandisfield, Mass.
II. Wood ashes received from Concord, Mass.

	Per cent. I.	 II.
Moisture at 100° C.,	7.14	9.54
Potassium oxide,	4.16	8.68
Phosphoric acid,	4.34	1.29
Insoluble matter,	3.24	*

170-172. I, II, III. Cotton seed hull ashes received from Hatfield, Mass.

		Per cent.	
	I.	II.	III.
Moisture at 100° C ,	15.40	16.33	7.65
Potassium oxide,	15.08	17.24	26.60
Phosphoric acid,	18.54	22.38	11.12
Insoluble matter,	21.34	22.37	5.30

173-175. TANKAGE.

I. Received from Marlborough, Mass.
II. Received from Westfield, Mass.
III. Received from So. Berlin, Mass.

		Per cent.	
	I.	II.	III.
Moisture at 100° C.,	7.47	6.80	6.45
Total phosphoric acid,	1.72	13.31	9.77
Available phosphoric acid,	1.08	*	5.44
Insoluble phosphoric acid,	.64	*	4.33
Nitrogen,	7.56	6.67	7.76

GROUND BONE AND ACIDULATED BONE.

176-179. I. Received from Holyoke, Mass.
II. Received from Northboro', Mass.
III. Received from Hudson, Mass.
IV. Received from So. Berlin, Mass.

		Per cent.		
	I.	II.	III.	IV.
Moisture at 100° C.,	4.54	.75	3.45	4.67
Total phosphoric acid,	20.28	23.80	21.40	22.00
Available phosphoric acid,	5.36	8.58	11.98	5.98
Insoluble phosphoric acid,	14.92	15.22	9.42	16.02
Nitrogen,	4.41	3.62	2.88	4.13

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*Not determined.

180-183. I, II. Received from Lincoln, Mass. I, bone from cattle; II, bone from hogs.
III. Received from So. Hadley, Falls, Mass.
IV. Received from Springfield, Mass.

	Per cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	4.07	4.15	2.95	7.47
Total phosphoric acid,	27.42	22.87	24.30	16.92
Available phosphoric acid,	8.62	13.17	*	9.42
Insoluble phosphoric acid,	18.80	9.70	*	7.50
Nitrogen,	2.53	2.52	2.66	2.67

NATURAL AND ACID PHOSPHATES.

184-188. I. Received from Westfield, Mass.
II, III. Received from Hingham, Mass.
IV, V. Received from Marlborough, Mass.

	Per cent.				
	I.	II	III.	IV.	V.
Moisture at 100° C.,	.82	9.03	.85	9.33	8.41
Total phosphoric acid,	27.24	40.15	27.12	12.06	20.36
Available phosphoric acid,	*	37.84	*	10.88	11.84
Insoluble phosphoric acid,	*	2.31	*	1.18	8.52
Insoluble matter,	22.37	*	*	31.88	*

189. Florida soft phosphate received from Boston, Mass.

	Per cent.
Moisture at 100° C.,	.78
Total phosphoric acid,	21.17
Available phosphoric acid,	1.47
Insoluble phosphoric acid,	19.70
Potassium oxide,	.21
Calcium oxide,	30.21
Ferric and aluminum oxides,	11.20
Carbonic acid,	2.08
Sulphuric acid,	trace
Insoluble matter,	37.79

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*Not determined.

190-193. I. Animal fertilizer received from Springfield, Mass.
II. Dried blood received from So. Hadley Falls, Mass.
III, IV. Dry ground fish received from Sunderland, Mass.

	Per cent.			
	I	II.	III.	IV.
Moisture at 100° C.,	4.68	7.15	7.15	8.00
Total phosphoric acid,	9.56	7.57	8.00	8.14
Available phosphoric acid,	2.94	*	*	*
Insoluble phosphoric acid,	6.52	*	*	*
Nitrogen,	7.15	11.56	8.93	8.18

194-198. COTTON SEED MEAL.

I. Received from Sunderland, Mass.
II, III. Received from No. Hatfield, Mass.
IV, V. Received from No. Hadley, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	5.18	7.20	5.45	8.05	6.37
Nitrogen,	7.09	5.80	7.95	6.95	7.04

199-202. I. Received from Hatfield, Mass.
II. Received from Southwick, Mass.
II, IV. Received from Springfield, Mass.

	Per cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.35	8.40	8.80	10.17
Nitrogen,	6.77	7.84	7.28	6.81

203-206. I, II. Dry sheep manure received from Arlington, Mass.
III, IV. Wet muck received from Waltham, Mass.

	Per cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.53	7.85	93.01	84.82
Potassium oxide,	1.98	1.42	*	*
Phosphoric acid,	.664	.728	*	*
Nitrogen,	1.77	1.71	.122	.250
Insoluble matter,	*	*	.87	5.95

COMPLETE FERTILIZERS.

207-211. I. Received from Littleton, Mass.
II. Received from Concord, Mass.
III. Received from Leverett, Mass.
IV, V. Received from Sunderland, Mass.

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*Not determined.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	18.93	5.87	12.20	11.52	8.05
Potassium oxide,	2.92	7.56	6.08	8.64	6.72
Total phosphoric acid,	11.76	11.50	8.57	9.90	9.22
Available phosphoric acid,	†	5.85	8.15	6.82	6.28
Insoluble phosphoric acid,	†	5.65	.42	3.08	2.94
Nitrogen,	2.18	5.28	1.06	3.68	3.84

212-216. I. Received from Spencer, Mass.
II. Received from Springfield, Mass.
III. Received from Westboro', Mass.
IV, V. Alkali Nitrate Phosphate received from Hopkinton, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.47	5.22	10.20	1.98	1.99
Potassium oxide,	4.48	8.20	8.12	.80	.96
Sodium oxide,	†	†	†	12.90	12.48
Total phosphoric acid,	13.17	13.50	10.65	14.90	15.46
Available phosphoric acid,	11.00	6.23	7.73	1.70	2.28
Insoluble phosphoric acid,	2.17	7.27	2.92	13.20	13.18
Nitrogen,	2.61	3.95	2.81	3.99	3.76

217-218. I. Carbonate of lime received from Springfield, Mass.
II. Plaster received from Springfield, Mass.

	Per cent.	
	I.	II.
Moisture at 100° C.,	.47	13.88
Calcium oxide,*	52.98	32.89
Sulphuric acid,	.312	41.22

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*Carbonic acid not determined.

†Not determined.

All parcels containing samples of fertilizers for examination must have express charges prepaid; they may be addressed to C. A. Goessmann, Hatch Experiment Station, Amherst, Mass. To avoid mistakes and delay, notice should also be given by postal card, that a package has been sent by express and the owner's name should be stated inside or outside of the packages.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
12	Sanderson's Formula "A,"	Lucien Sanderson, New Haven, Conn.,	So. Amherst.
16	Garden Special Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	Sunderland.
17	Complete Tobacco Manure,	H. J. Baker & Bro., New York, N. Y.,	Sunderland.
19	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	So. Ameerst.
102	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	Taunton.
156	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	Fall River.
160	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
20	Fish and Potash,	Pacific Guano Co., Boston, Mass.,	So. Amherst.
24	Berkshire Ammoniated Bone Phosphate,	Berkshire Mills, Bridgeport, Conn.,	So. Deerfield.
30	Alkali Nitrate Phosphate for Hay and Grain Crops,	American Fertilizer Co., Boston, Mass.,	Northboro.
35	Alkali Nitrate Phosphate for Hay and Grain Crops,	American Fertilizer Co., Boston. Mass.,	Boston.
124	Alkali Nitrate Phosphate for Hay and Grain Crops,	American Fertilizer Co., Boston, Mass.,	Springfield.
41	Church's Fish and Potash,	Dan. T, Church, Providence, R. I.,	Springfield.
91	New Patent Fertilizer,	John J. Peters & Co., Long Island City, N. Y.,	Amherst.
71	Grass and Grain Spring Top Dressing,	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Worcester.
3	Animal Corn Fertilizer,	Packers Union Fertilizer Co.,New York, N. Y.,	Amherst.
79	Animal Corn Fertilizer,	Packers Union Fertilizer Co., New York, N. Y.,	Westfield.
80	Complete Onion Manure,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
46	Complete Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Boston.
70	Anti Acid Phosphate,	American Fertilizer Co., Boston, Mass.,	Boston.
59	Complete Lawn Dressing,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
85	Superphosphate,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
22	Berkshire Complete Fertilizer for Tobacco,	Berkshire Mills, Bridgeport, Conn.,	So. Deerfield.
60	Complete Potato Manure,	Prentiss Brooks & Co., Holyoke, Mass.,	Holyoke.
8	Sheep Fertilizer,	New England Dressed Meat & Wool Co., Boston, Mass.	Boston.
9	Sheep Fertilizer,	New England Dressed Meat & Wool Co., Boston, Mass.	Boston.
174	Sheep Fertilizer,	New England Dressed Meat & Wool Co., Boston, Mass.	Boston.
37	State Grange Complete Potato and Vegetable,	American Fertilizer Co., Boston, Mass.,	Boston.
111	High Grade Superphosphate,	Russia Cement Co., Gloucester, Mass.,	Amherst.
158	High Grade Superphosphate,	Russia Cement Co., Gloucester, Mass.,	Pittsfield.
300	High Grade Superphosphate,	Russia Cement Co., Gloucester, Mass.,	Amherst.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	Guaranteed.
								Found.	Guaranteed.	Found.	Guaranteed.		
	Compound Fertilizers.												
12	Sanderson's Formula "A,"	11.97	3.24	3.11-3.75	5.58	2.58	2.56	10.72	9.63-11.11	8.16	6-8	7.76	7.65-8.24
16	Garden Special Fertilizer,	9.61	3.48	3.30-4.12	4.68	1.10	2.00	7.78	—	5.78	6 8	9.08	8-10
17	Complete Tobacco Manure,	2.93	5.60	4.53-5.36	4.34	3.60	1.02	8.96	—	7.94	4.	10.68	10-11*
19-102-156-160	Market Garden Manure,	11.10	3 28	3.30-4.12	4.22	4.78	.98	9.98	9-13	9.00	8-11	9.12	7-8*
20	Fish and Potash,	16.92	2.08	2.47-3.30	2 76	2.96	2.22	7.94	6-9	5.72	4-7	4.32	4-6*
24	Berkshire Ammoniated Bone Phosphate,	8.48	1.94	1.65-2.47	7.68	1.84	2.48	11.90	10-12	9.52	8-10	3.16	2-3
30-35-124	Alkali Nitrate Phos'te for Hay & Grain Crops	2.68	4.70	4.-4.5	.18	5.06	12.92	18.16	17-20	5.24	—	.56	—
41	Church's Fish and Potash,	17.94	2.14	2.06-2.88	2.30	4.60	2.30	9.28	7.5-10.5	6.90	6-8	1.36	2-3
91	New Patent Fertilizer,	13.38	7.02	—	—	5.94	.18	6.12	—	5.94	—	2.25	—
71	Grass and Grain Spring Top Dressing,	14.40	4.70	4.12-5.77	2.82	2.76	3.10	8.68	7-8	5.58	5-7	5.72	5-7
3-79	Animal Corn Fertilizer,	10.23	2.78	2.47-3.30	6 86	1.68	1.46	10.00	9-15	8.54	8-12	2.68	2-4*
80	Complete Onion Manure,	8.01	3.58	4.5-5.5	5.40	2 04	1.80	9.24	8-10	7.44	7-8	7.16	5-6
46	Complete Animal Fertilizer,	3.76	5.46	3.30-4.12	.52	6.00	3.64	10.16	14-17	6.52	—	7.48	7-8
70	Anti Acid Phosphate,	2.38	—	—	—	5.34	18.20	23.54	23.	5.34	—	—	—
59	Complete Lawn Dressing,	10 00	3.44	4.25-5.00	2.90	3.38	.44	6.72	5.75-6.75	6.28	4-5	9.40	7-8
85	Superphosphate,	8.23	2.33	2.06-2.47	5.34	1.36	5.18	11.88	10-12	6.70	8-10	3.92	2.5-3
22	Berkshire Complete Fertilizer for Tobacco,	6.70	2.60	2.47-3.30	6.42	2.02	3.28	11.72	10-12	8.44	8-10	8.06	6-8*
60	Complete Potato Manure,	6.07	3.54	4.12-4.94	3.46	3.28	2.68	9.42	7-9	6.74	5-6	9.20	8-9
8-9-174	Sheep Fertilizer,	11.54	2.38	—	—	—	—	1.28	—	—	—	1.42	—
37	State Grange Complete Potato and Vegetable	6.63	3.73	3.5-4	3.02	5.78	.82	9.62	—	8.80	8-9	6.70	7.-7.5
111-158-300	High Grade Superphosphate,	8.28	2.56	2.47-3.30	3.00	7.16	4 10	14.26	11-13	10.16	9-10	5.32	4-6

*Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
29	Alkali Nitrate Phosphate for Hoed Crops,	American Fertilizer Co., Boston, Mass.,	Northboro.
36	Alkali Nitrate Phosphate for Hoed Crops,	American Fertilizer Co., Boston, Mass.,	Boston.
115	Alkali Nitrate Phosphate for Hoed Crops,	American Fertilizer Co., Boston, Mass.,	Springfield.
51	Complete Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
61	Potato and Vegetable Manure,	Bowker Fertilizer Co., Boston, Mass.,	So. Sudbury.
259	Fish and Potash "D" Brand,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
118	Superphosphate,	Wm. J. Brightman & Co., Tiverton, Mass.,	Taunton.
221	King Philip Alkaline Guano,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
224	King Philip Alkaline Guano,	Clark's Cove Fertilizer Co., Boston, Mass.,	Pittsfield.
268	King Philip Alkaline Guano,	Clark's Cove Fertilizer Co., Boston, Mass.,	Greenfield.
276	Bay State Fertilizer G. G. Brand,	Clark's Cove Fertilizer Co., Boston, Mass.,	Greenfield.
135	Bay State High Grade Potato Manure,	E. Frank Coe, New York, N. Y.,	Taunton.
193	Fertilizer for Potatoes and Vegetables,	Lowell Fertilizer Co., Lowell, Mass.,	Boston
250	Fertilizer for Potatoes and Vegetables,	Lowell Fertilizer Co., Lowell, Mass.,	Springfield.
218	Potato and Tobacco Fertilizer,	Quinnipiac Co., Boston Mass.,	Westfield.
270	Fish and Potash,	Williams & Clark Fertilizer Co , Boston, Mass.,	Greenfield.
136	Potato, Onion and Tobacco Manure,	The Wilcox Fertilizer Works. Mystic. Conn.,	Amherst.
	Ground Bones.		
90	Fine Ground Bone,	Edward H. Smith, Northboro, Mass.,	Amherst.
14	Swift and Sure Bone Meal,	L. M. Shoemaker & Co., Philadelphia, Pa.,	Whately.
282	Swift and Sure Bone Meal.	L. M. Shoemaker & Co., Philadelphia, Pa.,	Greenfield.
89	Ground Bone,	Butchers' Rendering Association, Saugus, Mass.,	Saugus.
86	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
103	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
254	Fresh Ground Bone,	Bowker Fertilizer Co , Boston, Mass.	Springfield.
163	Fine Ground Bone,	Bradley Fertilizer Co., Boston, Mass.,	Boston.
238	Pure Bone Meal,	Quinnipiac Co., Boston, Mass.,	Fitchburgh.
244	Pure Bone Meal,	Quinnipiac Co., Boston, Mass.,	Springfield

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.			
			Found.	Guaranteed	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
	Compound Fertilizers.														
29-36-115	Alkali Nitrate Phos. for Hoed Crops,	2.55	5.04	5.-5.5	—	2.56	11.41	13.97	14-16	2.56	—	.96	—		
51	Complete Potato Manure, ...	11.05	3.62	3.30-4.12	4.92	2.85	.35	8.12	6.75-8.	7.77	4.5-6	10.00	10-12		
61	Potato and Vegetable Manure,.....	13.27	2.20	2.5 3.25	8.30	2.82	1.50	12.62	8-10	11.12	8-10	4.48	4-6		
259	Fish and Potash "D" Brand, ...	14.25	2.32	2.25-3.25	8.42	1.95	2.25	12.62	8-10	10.37	—	2.12	2-3		
118	Superphosphate,..................	11.55	2.33	2.5-3.25	2.25	5.37	2.85	10.47	8-11	7.62	6-8	4.84	5-6		
221-224-268	King Philip Alkaline Guano,.......	14.12	1.11	1.03-1.65	4.20	4.73	2.33	11.25	9-12	8.93	8-10	1.38	2-3		
276	Bay State Fertilizer G. G. Brand, ..	14.65	1.90	1.85-2.65	6.70	2.80	2.15	11.65	10-13	9.50	8.5-11	1.80	2-3		
135	Bay State High Grade Pot. Manure,	8.55	3.43	2.47-3.30	6.55	2.72	2.85	12.12	9-13	9.27	8-11	6.40	6-7		
193-250	Fertilizer for Potatoes & Vegetables,	8.12	3.24	2.47-3.30	2.82	10.10	3.38	16.30	8-11	12,92	7-9	4.40	4-5		
218	Potato and Tobacco Fertilizer, ...	15.37	2.13	2.06.2.88	4.70	5.83	1.42	11.95	9-13	10.53	8-12	3.00	3-4		
270	Fish and Potash, ...	19.02	2.57	2-3	2.62	4.05	1.85	8.52	6-9	6.67	4-6	4.04	4-6		
136	Potato, Onion and Tobacco Manure,	13.40	3.42	3.30-4.30	5.32	3.94	1.66	10.92	8-10	9.26	7-9	6.50	6-7		
												Mechanical Analysis.			
	Ground Bones.											Fine.	Fine. Med.	Med.	Coarse Med.
90	Fine Ground Bone, ...	.73	3.62	3-4	—	8.58	15.22	23.80	23-24	8-58	8-9	56.20	37.40	6.40	—
14-282	Swift and Sure Bone Meal,........	.50	5.86	4.12-4.94	—	8.78	12.28	21.06	20-25	8.78	—	70.20	25.00	4.80	—
89	Ground Bone, ...	6.65	1.37	—	—	8.52	18.52	27.84	—	8.52	—	51.80	24.30	23.90	—
86-103-254	Fresh Ground Bone,...............	6.85	2.88	2.47-3.30	—	12.47	8.75	21.22	18-22	12.47	5-7	37.60	25.30	28.40	8.70
163	Fine Ground Bone, ...	7.10	3.60	2.5 3.5	—	7.13	11.42	18.55	21-23	7.13	—	56.70	19.70	17.40	6.20
238-244	Pure Bone Meal,..................	6.25	3.91	2.47-4.12	—	10.35	16.37	26.72	20-25	10.35	—	63.90	16.70	11.60	7.80

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*Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY NO.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT
	Compound Fertilizers.		
132	Fish and Potash,	W. J. Brightman & Co., Tiverton, R. I.,	Taunton.
123	Ammoniated Bone Phosphate,	National Fertilizer Co., Bridgeport, Conn.,	Hadley.
134	Ammoniated Bone Phosphate,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
142	Low Grade Fish and Potash,	Leander Wilcox, Mystic, Conn.,	Amherst.
164	Great Planet "A" Manure,	Clark's Cove Fertilizer Co., Boston, Mass.,	Pittsfield.
92	Animal Fertilizer,	N. Roy & Son; So. Attleboro, Mass.,	So. Attleboro.
232	Animal Fertilizer,	N. Roy & Son, So. Attleboro, Mass.,	Amherst.
235	Champion Garden Fertilizer,	Butchers' Rendering Association, Medford.	Medford.
88	Tankage,	Butchers' Rendering Association, Medford.	Medford.
18	Special Potato Manure,	Pacific Guano Co., Boston, Mass.,	So. Amherst.
196	Special Potato Manure,	Pacific Guano Co., Boston, Mass ,	Williamstown.
117	All Soluble,	Armour & Co., Chicago, Ill.,	Hadley.
204	All Soluble,	Armour & Co., Chicago, Ill.,	Williamstown.
203	Tobacco Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Westfield.
188	Fish and Potash,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
100	Special Potato Fertilizer,	H. F. Tucker & Co., Boston, Mass.,	Taunton.
184	Special Potato Fertilizer,	H. F. Tucker & Co., Boston, Mass..	Middlefield.
261	Special Potato Manure,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Fitchburg.
75	Complete Fertilizer for Corn and Grain,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
263	Complete Fertilizer for Corn and Grain,	Bradley Fertilizer Co., Boston, Mass..	Fitchburg.
305	Complete Fertilizer for Corn and Grain,	Bradley Fertilizer Co , Boston, Mass.,	Fitchburg.
50	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
105	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Worcester.
66	Special Truck Fertilizer,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	So. Sudbury.
128	Phosphate,	Quinnipiac Co., Boston. Mass.,	Taunton.
153	Phosphate,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
21	High Grade Special for Potatoes and Tobacco.	Williams & Clark Fertilizer Co., Boston, Mass.,	Sunderland.
271	High Grade Special for Potatoes and Tobacco,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
132	Fish and Potash,	15.75	2.36	2.06-2.88	2.04	5.48	2.20	9.72	7-10	7.52	6-8	2.68	2-3
123-134	Ammoniated Bone Phosphate,	16.98	1.84	1.65-2.47	.84	8.88	1.54	11.26	9-11	9.72	7-9	2.56	2-3
142	Low Grade Fish and Potash,	18.64	2.66	2.47-3.30	—	8.18	.46	8.64	6-8	8.18	6-7	4.68	3-4
164	Great Planet "A" Manure,	11.33	3.20	3.30-4.12	4.10	4.34	1.12	9.56	9-13	8.44	8,5-11.5	7.68	6 7
92-232	Animal Fertilizer,	4.74	5.42	5-5-5	—	8,14	8.06	16.20	15.5-16.5	8.14	6-8	4.16	4-4.5
235	Champion Garden Fertilizer,	2.63	4.14	3.8-4.2	—	6.26	5.82	12.08	12-14	6.26	5 6	8.08	6.5-7.
88	Tankage,	3.38	4.74	—	—	5.64	9.46	15.10	–	5.64	—	-—	—
18-196	Special Potato Fertilizer,	13.04	2.49	2.47-3.30	2.18	4.80	1.98	8.96	7-11	6.98	5-8	4.88	5-6
117-204	All Soluble,	2.63	2.94	2.47-3.30	1.92	9.60	1.18	12.70	11-15	11.52	8-11	5.92	4-5
208	Complete Tobacco Fertilizer,	11.74	3.26	3.30-4.12	3.58	4.48	2.56	10.62	—	8.06	8-10	6.32	4-5*
188	Fish and Potash,	15.54	2.35	2.06-2.88	2.44	4.54	1.94	8.92	7-10	6.98	6-8	2.56	2-3*
100-184	Special Potato Fertilizer,	13.88	2.61	3.40	2.22	7.80	1.28	11.30	9-13	10.02	8-11	6.12	6-7
261	Special Potato Manure,	10.97	4.19	3.7-4.5	5.24	2.32	1.66	9.22	11-14	7.56	8-9	6.22	5.4-6.4
75-263-305	Complete Fertilizer for Corn and Grain,	9.17	3.02	3.30-4.12	3.46	8.64	2.74	14.84	13-16	12.10	12-14	5.80	3-4*
50-105	Hill and Drill Phosphate,	12.67	2.64	2.5-3.5	7.30	3.70	1.80	12.80	12-13	11.00	9-11	3.00	2-3
66	Special Truck Fertilizer,	9.45	4.73	4.10-5.	4.34	3.60	.64	8.58	8-11	7.94	7-9	6.90	6.92-8.*
128-153	Phosphate,	13.72	2.54	2.47-3.30	6.06	5.12	1.10	12.28	10-14	11.18	9-12	2.40	2-3.5
21-271	High Grade Special for Potatoes and Tobacco	10.75	3.24	3.71-4.12	4.18	4.90	.38	9.46	8-11	9.08	7-9	7.75	7-9*

*Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of manufacturer.	Sampled at
	Compound Fertilizers.		
149	Lawn Dressing,	Lowell Fertilizer Co., Lowell, Mass.,	Boston.
194	Lawn Dressing,	Lowell Fertilizer Co., Lowell, Mass.,	Boston.
290	Lawn Dressing,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
94	Ammoniated Bone and Potash,	Armour & Co., Chicago, Ill.,	Worcester.
183	Ammoniated Bone and Potash,	Armour & Co., Chicago, Ill.,	Williamstown.
309	Animal Fertilizer,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Fitchburg.
155	Animal Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Boston.
288	Animal Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
161	Complete Manure for Potatoes and Roots,	Russia Cement Co,. Gloucester, Mass.,	Amherst.
171	Complete Manure for Potatoes and Roots,	Russia Cement Co., Gloucester, Mass ,	Pittsfield.
294	Complete Manure for Potatoes and Roots,	Russia Cement Co., Gloucester, Mass.,	Amherst.
58	Fish and Potash,	Prentiss, Brooks & Co., Holyoke, Mass.	Holyoke.
101	Fish and Potash,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
121	Fish and Potash,	National Fertilizer Co., Bridgeport, Conn.,	Spencer.
138	Fish and Potash,	National Fertilizer Co., Bridgport, Conn.,	Hadley.
302	Corn Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Fitchburg.
77	X. L. Superphosphate,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
133	X. L. Superphosphate,	Bradley Fertilizer Co., Boston, Mass.,	Amherst.
106	Farm and Garden Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Worcester.
200	Corn Manure,	Quinnipiac Co., Boston, Mass.,	Westfield.
265	Corn Manure,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
5	High Grade Potato Manure,	Packers' Union Fertilizer Co., New York, N. Y.,	Amherst.
39	High Grade Potato Manure,	Packers' Union Fertilizer Co., New York, N. Y.,	Westboro.
144	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	Hadley.
312	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
275	Standard Fertilizer,	Standard Fertilizer Co., Boston, Mass.,	Greenfield.
176	Gold Brand Excelsior Guano,	E. Frank Coe & Co., New York, N. Y.,	Dighton.
215	Bay State Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Pittsfield.
223	Bay State Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
264	Bay State Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Greenfield.
313	Dry Ground Fish,	National Fertilizer Co., Bridgeport, Conn.,	Amherst.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
149-194-290	Lawn Dressing,	4.67	3.95	4.12-4.94	2.76	8.62	1.92	13.30	9-11	11.38	8-10	4.90	5-6
94-183	Ammoniated Bone and Potash,	5.85	3.30	2.47-.330	3.40	5.04	1.16	9.60	8-10	8.44	6-7	1.05	1-2*
309	Animal Fertilizer,	5.67	4.55	3.30-4.12	1.54	5.10	2.82	9.46	10-12	6.64	6-8	5.70	4-6
155-288	Animal Fertilizer,	8.12	3.36	2.47-3.30	3.08	10.44	3.32	16.84	8-11	13.52	7-9	4.36	4-5
161-171-294	Complete Manure for Potatoes and Roots,	8.30	3.86	3.71-4.53	4.34	3.98	2.30	10.62	9-11	8.32	7-8	8.52	8.5-10*
58	Fish and Potash,	5.27	4.32	3.30-4.12	.38	3.60	3.32	7.30	6-7	3.98	4-5	4.84	4-5
101-121-138	Fish and Potash,	9.42	2.94	2.47-3.30	2.04	4.28	1.62	7.94	8-9	6.32	—	4.20	3-4
302	Corn Phosphate,	10.27	2.43	2.06-2.88	5.24	7.70	2.30	12.54	10-13	12.94	9-11	2.40	1.5-2.5
77-133	X. L. Superphosphate,	13.92	2.54	2.5-3.25	6.02	3.88	1.86	11.76	11-14	9.90	9-11	2.32	2-3*
106	Farm and Garden Phosphate,	12.47	1.76	1.5-2.5	4.74	4.98	2.68	12.40	10-13	9.72	8-10	2.76	2-3
200-265	Corn Manure,	15.32	2.32	2.06-2.80	6.40	3.44	1.80	11.64	10-14	9.84	9-12	2.68	1.5-2.5
5-39	High Grade Potato Manure,	7.62	2.59	2.06-2.88	7.12	1.92	1.20	10.24	9-15	9.04	8-12	6.68	6-8*
144-312	Vegetable, Vine and Tobacco Fertilizer,	12.85	2.31	2.05-2.88	6.40	3.20	1.02	10.62	9-15	9.60	8-12	6.92	6-8
275	Standard Fertilizer,	12.80	2.23	2-3	5.76	3.72	2.04	11.52	11-14	9.48	9-12	2.32	2-3
176	Gold Brand Excelsior Guano,	11.75	2.70	2-3	7.16	1.66	.90	9.72	9-13	8.82	8-11	6.32	6-8
215-223-264	Bay State Fertilizer,	13.10	2.62	2.47-3.30	1.80	6.26	4.48	12.54	10-14	8.06	9-12	2.48	2-3
313	Dry Ground Fish,	7.07	8.55	—	—	—	—	8.07	—	—	—	—	—

*Sulphate of potash, the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
211	Oats and Top Dressing Fertilizer,	The Rogers & Hubbard Co., Middletown, Conn.,	Westfield.
13	Formula "A,"	Quinnipiac Co., Boston, Mass.,	So. Amherst.
179	Strawberry Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
99	Lawn and Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Worcester.
252	Lawn add Garden Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
82	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
191	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Westfield.
197	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Pittsfield.
278	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Greenfield.
95	Potato and Root Manure,	Wm. J. Brightman & Co., Tiverton, R. I.,	Taunton.
129	Bay State Potato Manure,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
152	High Grade Ammoniated Bone Superphosphate[1]	E. Frank Coe & Co., New York, N. Y.,	Dighton.
257	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.,	Fitchburg.
298	Bone Fertilizer,	John C. Dow & Co., Boston, Mass.,	Boston.
192	Nobsque Guano,	Pacific Guano Co., Boston, Mass.,	Williamstown.
6	High Grade Oats and Clover Fertilizer,	Packers' Union Fertilizer Co., New York, N. Y.,	Amherst.
57	High Grade Oats and Clover Fertilizer,	Packers' Union Fertilizer Co., New York, N. Y.,	Westboro.
157	Potato Phosphate,	Lowell Fertilizer Co., Lowell, Mass.,	Boston.
246	Potato Phosphate,	Lowell Fertilizer Co., Lowell, Mass.,	Springfield.
289	Potato Phosphate,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
120	Quinnipiac Potato Manure,	Quinnipiac Co., Boston, Mass.,	Taunton.
167	Quinnipiac Potato Manure,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
173	Quinnipiac Potato Manure,	Quinnipiac Co., Boston, Mass.,	Westfield.
284	Potato and Tobacco Fertilizer,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
130	Essex Complete Manure for Corn and Grain,	Russia Cement Co., Gloucester, Mass.,	Amherst.
299	Essex Complete Manure for Corn and Grain,	Russia Cement Co., Gloucester, Mass.,	Amherst.
281	Dry Fish Guano,	Bradley Fertilizer Co., Boston, Mass.,	Greenfield.
32	Ward's Inodorous Plant Food,	American Fertilizer Co., Boston, Mass.,	Boston.
143	Ward's Inodorous Plant Food,	American Fertilizer Co., Boston, Mass.,	Springfield.
44	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
145	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Amherst.
199	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Pittsfield.
277	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Co., Boston, Mass.,	Greenfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassiam Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
211	Oats and Top Dressing Fertilizer,	3.85	9.27	8.80-9.70	—	4.40	4.56	8.96	7.85-8.75	4.40	—	8.16	8.35-9.25
13	Formula "A,"	8.28	4.00	3.25-3.91	3.68	2.34	3.20	9.22	9.75-11.25	6.02	—	8.20	7.75-8.34
179	Strawberry Manure,	8.87	2.91	2.47	4.37	2.84	.69	7.90	—	7.21	6.	9.36	4.
99-252	Lawn and Garden Dressing,	8.67	3.94	3.25-4.25	3.96	3.09	4.25	11.30	8-10	7.05	6-8	4.84	5-6
82-191-197-278	Potato Manure,	11.75	2.32	2.5-3.25	2.71	4.64	2.67	10.02	8-10	7.35	6-8	5.36	5-6
95	Potato and Root Manure,	10.00	3.10	3.30-4.12	4.30	4.33	1.51	10.14	9-13	8.63	8-11	6.96	7-8
129	Bay State Potato Manure,	11.15	2.17	2.47-3.30	2.83	3.44	2.65	8.92	7-11	6.27	6-9	5.40	5-6
152	High Grade Ammoniated Bone Superphos'te	9.80	2.19	2-2 5	7.45	1.83	3.20	12.48	11-13	9.28	9-11	2.40	1.85
257	Ammoniated Wheat and Corn Phosphate,	12.32	2.04	2-3	4.40	7.11	2.71	12.13	11-15	11.51	10-13	1.52	1.6-2.7
298	Bone Fertilizer,	5.45	2.16	2.06-2.47	—	7.14	11.52	18.66	18-22	7.14	—	2.96	3-4
192	Nobsque Guano,	13.70	2.23	1.15-1.65	4.41	4.39	2.11	10.91	9-12	8.80	8-10	1.84	2-3
6-57	High Grade Oats and Clover Fertilizer,	11.26	.37	—	8.34	3.34	.95	12.63	—	11.68	11-13	2.08	2-3*
157-246-289	Potato Phosphate,	6.85	3.23	3.30-4.12	2.59	9.15	3.55	15.29	8-10	11.74	7-8	6.52	6-7
120-167-173	Quinnipiac Potato Manure,	12.12	2.30	2.47-3.30	2.22	4.29	2.67	9.18	7-11	6.51	6-9	5.48	5-6
284	Potato and Tobacco Fertilizer,	14.97	2.06	2.06-2.88	4.15	5.00	2.76	11.91	9-13	9.15	8-11	2.88	3-4
130-299	Essex Complete Manure for Corn and Grain	8.25	3.77	3.71-4.53	4.75	2.90	3.52	11.17	10-11	7.65	7.5-9	12.00	9.5-11
281	Dry Fish Guano,	10.35	8.40	7.41-9.06	—	5.56	3.80	9.36	7-9	5.56	—	—	—
32-143	Ward's Inodorous Plant Food,	2.72	3.44	4-4.5	—	3.70	12.80	16.50	14-15	3.70	—	.76	—
44-145-199-277	Complete Manure for Potatoes & Vegetables	10.85	3.85	3.71-4.53	4.60	4.05	2.20	11.25	9-13	8.65	8-11	5.94	6-7*

*Sulphate of potash, the source of potash.

TRADE VALUES
OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1896. **Cents per pound.**
Nitrogen in ammonia salts,	15.
“ “ nitrates,	13.5
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	14.
“ “ “ cotton-seed meal,	12.
“ “ “ fine ground bone and tankage,	13.5
“ “ “ fine ground medium bone and tankage,	12.
“ “ “ medium bone and tankage,	9.
“ “ “ coarse bone and tankage,	3.
“ “ “ hair, horn-shavings and coarse fish scraps,	3.
Phosphoric acid soluble in water,	5.5
“ “ soluble in ammonium citrate,	5.
“ “ in fine bone and tankage,	5.
“ “ in fine medium bone and tankage,	4.
“ “ in medium bone and tankage,	2.5
“ “ in coarse bone and tankage,	2.
“ “ in fine ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	4.5
“ “ insoluble (in am. cit.) in mixed fertilizers,	2.
Potash as High Grade Sulphate, and in mixtures free from Muriate,	5.
“ “ Muriate,	4.5
The manurial constituents contained in feedstuffs are valued as follows:	
Organic Nitrogen,	12.
Phosphoric acid,	4.5
Potash,	5.

The above trade values are the figures at which, in the six months preceding March, 1896, the respective ingredients could be bought at *retail for cash in our large markets*, *in the raw materials*, which are the regular source of supply.

Amherst, Mass., August 1st, 1896.

(Issued jointly by Hatch Experiment Station and Massachusetts State Board of Agriculture.)

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 41.

ON THE USE OF TUBERCULIN.

AUGUST, 1896.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1896.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

HENRY H. GOODELL, LL. D.,	*Director.*
WILLIAM P. BROOKS, B. SC.,	*Agriculturist.*
GEORGE E. STONE, PH. D.,	*Botanist.*
CHARLES A. GOESSMANN, PH. D., LL. D.,	*Chemist* (Fertilizers).
JOSEPH B. LINDSEY, PH. D.,	*Chemist* (Foods and Feeding).
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
LEONARD METCALF, B. S.,	*Meteorologist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*
RALPH E. SMITH, B. SC.,	*Assistant Botanist.*
HENRI D. HASKINS, B. SC.,	*Assistant Chemist* (Fertilizers).
ROBERT H. SMITH, B. SC.,	*Assistant Chemist* (Fertilizers).
EDWARD B. HOLLAND, B. SC.,	*Ass't Chemist*(Foods and Feeding).
GEORGE A. BILLINGS, B. SC.,	*Ass't Chemist*(Foods and Feeding).
ROBERT A. COOLEY, B. SC.,	*Assistant Entomologist.*
JOSEPH H. PUTNAM, B. SC.,	*Assistant Horticulturist.*
CHARLES E. TISDALE,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

HATCH EXPERIMENT STATION, Amherst, Mass.

THE APPLICATION OF TUBERCULIN

IN THE

Suppression of Bovine Tuberculosis

BY

PROF. DR. B. BANG, Copenhagen.

From the Deutschen Zeitschrift für Thiermedicin und vergleichende Pathologie, XXII Band.

In a country like Denmark, where for years stockraising and dairying have formed the chief source of national prosperity, the ravages of tuberculosis necessarily claimed the attention of farmers and urged them on to its suppression. Although the old ideas that tuberculosis is a constitutional disease intimately connected with forced milk-production, and that the disease, or a pre-disposition for it, is inherited, are still held, yet there has long been a suspicion of its contagious character. During the last ten years the scientific recognition of this idea has forced itself gradually into the minds of the farmers. Intelligent owners of dairy stock have exerted themselves for decades to secure protection against the devastation of the disease. To accomplish this they have not allowed sick animals to serve as breeders. These animals have been removed as early as possible from the stable, and their stalls or the entire stable disinfected. These efforts were certainly not without significance. The condition of health was improved, especially in places where the entire herd was yearly subjected to thorough investigation by a competent veterinarian, and where the owner and veterinarian worked harmoniously together. But even with these conditions it was hardly possible to be freed from the disease. In spite of all progress in clinical diagnosis we were not in condition to discover the majority of the cases in their early stages of development. Here again with tuberculosis the old practice continued as was formerly the case with pleuro-pneumonia. The hidden (latent) cases always remained and were continually coming to the surface. Koch's grand discovery, of tuberculin, alone, placed us in position to discover early even latent tuberculosis.

As soon as this new material was made accessible for veterinary purposes, I inaugurated very comprehensive experiments with it.[1]

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[1] Berliner thieraerzth. Wochenschrift. 1891. S. 115; Tidskrift for Veter. 1891 p. 25 u. 304; Ugeskrift for Landmänd 1892.

Having become convinced of its great diagnostic value, I was able, in the spring of 1892, supported by the state, to begin another experiment. The purpose of this was to obtain practical proof of the possibility, with the aid of tuberculin, of completely freeing a large infected herd from tuberculosis. That is, to rear in the course of a few years, an entirely new and healthy stock from the old one. This was to be done by culling, disinfection, and prevention of spreading through the milk. This fundamental experiment which was executed at the farm, Thurebylille, on the island of Seeland, is more carefully described below. (See page 22).

In the Danish parliament the proposition for a new law relative to contagious diseases has been discussed for years. By this it was proposed to establish means for the suppression of tuberculosis.*

Knowledge of the wide extent of latent tuberculosis obtained by investigation in Denmark and elsewhere rendered it clear that mild methods were out of the question. I was at that time of the opinion that the best way for the state to proceed against tuberculosis would be the following.

The government should furnish cattle owners tuberculin free of cost, under the condition that they use this material in a rational manner for the extermination of tuberculosis, the state at the same time should pay the veterinarians for the injection and supervision of the temperature observations. The last provision would of course be very expensive to the state, but would be necessary. An extended use of tuberculin was only to be expected when its application could be made free of expense or very nearly so, to the owner, and only in the manner indicated was it considered possible to secure the rational application of tuberculin.

The minister of the interior readily accepted my ideas and as the result of a discussion in Parliament the Tuberculin Law of 1893,† was issued. This law provides for the expenditure by the minister of the interior of $13,500.00 (50,000 krone) annually for five years for the accomplishment of the above-named object. The law contains the condition that tuberculin must be applied to the investigation of young cattle, that the free tuberculin tests shall be granted only to those owners who can offer therefor a guarantee that they are in condition to separate the healthy animals from those which show a reaction. The limitation of the test to young cattle was made for two reasons; first, because it was seen that the raising of new healthy herds was most important; second, because at that time tuberculin was very dear and the quantity to be consumed was of no slight economic importance. I soon arrived at the conclusion however, that in very many cases it would be far more rational to inoculate the whole herd. From the first it was to be assumed that many, especially small herds, would be found entirely healthy. Proof that this was the situation appeared to be not only of great scientific, but also of much practical interest. It could then be assumed that in many cases the number of diseased animals would be relatively small, and if such were the case the owner would often be in a position to accomplish the work by removing the reacting animals from the others. Indeed in many instances he could quickly secure a healthy herd by the sale of single animals.

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* Compare my article. "Die Tuberculose unter den Hausthieren in Dänemark." Diese Zeitschr. Bd. XVI. S. 428..

†At this time appeared the new law, paragraph eleven of which has regulations for the exclusion from commerce of animals apparently tuberculous, as well as for the pasturing of such animals together with others. This further forbids the uninspected use of meat of such animals and also the use of milk from cows suffering udder tuberculosis.

Even when tuberculosis was considerably spread among the grown animals it would be, as a rule, most profitable to learn immediately the exact situation and from the very beginning carry out a complete separation of the herd into two divisions and, after the example of my Thurebylille experiment, attempt a gradual purifying of the herd. Since the summer of 1893, tuberculin has been prepared in my laboratory by my assistant, Mr. Stribolt, and its price has consequently been kept very low. Although the law had in prospect only the inoculation of young cattle, conditions have so changed that now, as a rule, the entire herd is inoculated at the start. Sometimes animals selected for early slaughter are, however, omitted. With the endorsement of the government I now furnish from my laboratory (subsidized by the state) tuberculin free of cost for the inoculation of grown animals in those herds in which the testing of young cattle is paid for by the state. This is done when the owner desires a total inoculation and under the condition that he will separate the reacting animals from the healthy ones in the same manner as the law requires for young cattle. For the testing of grown animals the owner must pay the veterinarian according to private arrangements. This work can be done at very low cost in small herds, indeed, in many cases, no separate payment is demanded for the investigation of the grown cattle. The veterinarian is paid for testing the young cattle and must consequently be occupied on the premises.[10] On large farms where the grown and young cattle cannot be tested together he must of course be separately paid by the owner. In many cases, I have been able to send out an assistant for such work free of cost.

The tuberculin is furnished to the veterinarian and at the same time a prepared blank on which he must write the observed temperatures. These blanks are to be returned to me shortly after the test so that I am in position at the proper time to make possible corrections in the conclusions drawn in the case. Such a centralization in the management causes a very large amount of work. I consider it however a necessity, at least during the first few years. Only in such a manner would it be possible to make the large amount of material of scientific value.

The tuberculin tests have during the last two years been gradually adopted and especially during the last year was the use so extended that at certain times it was very difficult to prepare the required amount of material.

Whereas in July, 1894, in publishing the first review of the result,[11] I was able to report only 327 herds tested by 69 veterinarians, now, at the end of October, 1895, I have reports on 1972 herds, tested by 210 veterinarians.

At first the farmers were backward in many places and the extent of the testing depended largely on the personal influence of the veterinarian, but now the significance of the matter is quite widely understood. The demand for free tuberculin has so increased during this year that in order to meet all requests it will be necessary to increase the sum to be expended.[12] At first certain portions of the

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10. The veterinarian is required to measure the temperature and shortly thereafter to make the injection, then, at latest, nine hours after the injection, he must be present and take the temperature every two or three hours till about twenty-four hours after the injection. It is advisable to inject at from eight to ten in the evening. For this work the veterinarian is paid at least $4.32, i. e., $1.08 for the evening visit and the remainder for the following day. In addition, he receives mileage according to rules of the public service and is paid an additional sum in case the number of animals exceeds fifteen. For from sixteen to thirty animals he receives 13.5 cents per head and for each over 30, 6.75 cents per head. When the farm is at a distance from the veterinarian the average cost of inoculating a herd is increased to about $6.75. At first it was stipulated that two temperature observations should be taken before the injection—the first to be about 12 hours before. Although such a procedure is desirable in single cases, experience has nevertheless shown that a single observation before the injection is sufficient for practical needs. The veterinarian can then cover more ground and the state save thereby a considerable sum, at least $1.08 and mileage for each investigation. The owner is required to furnish the necessary assistants, a goodly number of whom are required for large herds. These assistants must introduce the thermometer and hold it fast so that the veterinarian needs only to read the temperature.

11. Maanedskrift for Dyrlaeger. Bd. VI. This paper, which is a lecture given before the Central Union of Danish Veterinarians, is published in French by Prof. Gosse in Geneva in his book. "La lutte contre la tuberculose en Denmark."

12. The government has already this fall laid before Parliament an act in which the yearly sum is increased to $27,000.00.

country only were represented, but now demands are received from nearly all sections.

The number of inoculated animals is now 53,303.[13] Of these 20,665 (38.7%) have reacted, while 32,638 (61.3%) have not reacted.

In the different provinces there appears to be a great difference in the extent of the disease.

	Number of Herds.	Number of Healthy Animals.	Number of Reacting Animals.	Per cent of Healthy Animals.	Per cent of Reacting Animals
Jütland	819	13,650	10,414	56.7	43.3
Fünen	311	4,667	2,002	70.0	30.0
Seeland	298	5,031	5,130	49.5	50.5
Möen	81	1,110	605	74.9	35.1
Lolland-Falster	63	1,931	926	67.6	32.4
Bornholm	400	6,247	1,588	79.7	20.3
	1,972	32,636	20,665	61.3	38.7

These numbers are still too small to give an exact view of the extent of tuberculosis, but when we remember that former enumerations gave results which agree with these, the figures have importance[14].

Without doubt tuberculosis on Bornholm and Fünen is much less extended than on Seeland and Jütland. It is quite interesting to note that this exactly agrees with the views which I presented years ago on the basis of reports received from veterinarians.[15]

In order to do no injustice to Seeland and Jütland it must be added that a relatively greater number of large herds have been inoculated than on Fünen and Bornholm. The tuberculosis investigations have fully established the earlier observations that the disease, as a rule, is much more extended in large herds than in small ones. This appears from the following table, in which the total number of 1,390 inoculated herds are separated into large and small, i. e., into those of more than and those of less than 50 head respectively:

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[13] Denmark has relatively a very large number of cattle. In 1893 this amounted to 1,696,000 head among a population of 2,200,000. The country has something more than 70,000 peasant farms and over 1,800 larger estates.

[14] Compare "La lutte contre la tuberculosis" page 14 (July, 1894) and page 49 (Feb., 1895). For Jütland the figures are now more favorable and for Seeland less favorable than at first.

[15] Compare "Tuberculosis in the Domestic Animals of Denmark." This Journal Vol. XVI. Page 365.

No.	No. of Healthy Animals.	No. of Reacting Animals.	No. of herds arranged according to percentage of reacting animals.				No. of herds of entirely sound animals.	No. of herds with one or two reacting animals.
			0–24	25-49	50-74	75-100		
Large 107	4,679 =40.2%	6,951 =59.8%	23	11	47	26	3	4
Small 1283	16,224 =67.8%	7,705 =32.2%	716	239	210	118	306	277
Total 1390	20,903	14,656	739	250	257	144	309	281

Of these 1,390 herds (35,559 animals), 107 (11,630 animals) were large and 1283 (23,929 animals) were small. Among the former the reacting animals amounted to 59.8 per cent, and among the latter only 32.2 per cent. The better health of the small herds appears distinctly in that part of the table in which they are arranged according to the percentage of reacting animals. While about two-thirds of the large herds contained over 59 per cent of reacting animals and about one-fourth, over 75 per cent, the relative number in the small herds was very much less. In more than one-half of these, the number was under 25 per cent, while not more than one-tenth showed 75 per cent or more. 277 small herds contained only one or two reacting animals. This was true of only four large herds. Finally, 309 herds, i. e., 306 small and 3 large, were quite free from tuberculosis. Of these healthy herds, 69 had from four to ten head while 240 contained 11 to 55 head. The reason for the greater morbidity in the large herds is not very apparent. This may be due to the longer existence of tuberculosis in the large herds. The owners of these began to improve the dairy industry many years ago, often by the importation of foreign cattle, especially from England. It is quite possible that tuberculosis was introduced among them at this time.

The longer the disease has existed in a herd the wider would be its distribution. Danger from contagion in common drinking-troughs is greater in large herds because these troughs have been more extensively introduced among them. Probably the practice so common in large herds of changing the stalls of animals according to the fodder given and milk yielded, is a considerable source of infection. The method certainly contributes to the spread of the disease.

In Jütland the wide extent of the disease must be due in some measure to the old time fondness of its peasants to barter.

Because of this practice the number of herds in this province which have been maintained through home breeding is probably not large. It is certainly far smaller than the number of the corresponding herds on Fünen, especially on the southern part of the island.[6]

The proof of the existence of a large number of entirely healthy herds appears to me to be of special interest. It will certainly weaken the theory that tuberculous bacilli are everywhere present. This idea is firmly fixed in the heads of many of the laity and even of physicians themselves, and seriously threatens all energetic and well-planned attemps at annihilation of tuberculosis. The knowledge that tuberculosis is not a necessary evil gives confidence that this and all other purely contagious diseases may be removed from our herds.

Three years ago I personally experimented on two peasant farms (at Elkenoere on Falster island) in order to prove the existence of entirely healthy herds. These herds were particularly interesting. They were relatively large, 38 and 39 head,[16] of finely developed animals of a well-formed milk type (the red Danish race). They gave a yearly average of 4,000 litres of milk per head. In founding the race, in and in breeding was largely practised. A large part of both herds originated from one cow, bought in the year 1862. Here were, therefore, many of the conditions which have long been supposed to favor tuberculosis and still not a single animal reacted.

Only one yearling bull showed a slight rise of temperature (from 38.6° to 39.7°). I caused him to be killed, but found no trace of tuberculosis. There was an actinomycotic swelling in the pharynx.[17]

The health of both of these herds is further of interest because many of the animals had often been exhibited at cattle shows. They had thus had frequent opportunity of coming in contact with tuberculous animals as well as men. The fact that they remained healthy, strongly supports the theory that the spread of the disease requires a prolonged living together. Communication of tuberculosis by feeding is not considered here.

Among the healthy herds there are many others of fine quality. Here is sufficient proof that with the exclusion of contagion, cows may be developed to produce a high milk yield without danger of becoming tuberculous. The reason why highly developed dairy herds are often tuberculous is simply that the improvement of the herd is generally based on the importation of breeding animals. This is the cause of the infection. In this manner tuberculosis has often been spread from large estates to the peasant farms, especially through the sale of calves.

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[6] Compare "Tuberculosis among the Domestic Animals of Denmark." This Journal Vol. XVI. page 384.

[16] The one had 18 cows (2 1-2 to 13 years old) 3 bulls (1, 1 1-2 and 3 years old), 17 head of calves and heifers. The other had 22 cows, 4 bulls (among them a prize 6 years old), 13 calves and heifers. Compare Ugeskrift for Landmänd" 1892.

[17] Abscedirende Actinomykome in den Schlundkopfdrusen.

As soon as tuberculin inoculation was undertaken on a large scale the public was surprised at the very large number of reacting animals, even in herds of healthy appearance. I refer to the work as done first by Koepp in Dorpat, then by Siedamgrotzky and Eber in Saxony, Nocard in France, Malm in Norway and others.

The Danish investigations have yielded exactly similar results. Where tuberculosis exists it often has an extent which no one had suspected. The discovery produces at first a benumbing effect and is always very painful to the owner of dairy stock. Because of this it cannot be made too emphatic that there is a great difference between what was formerly termed tuberculosis and what, as a result of the tuberculin test, is now indicated by the same word. When a reacting animal is butchered, the butcher very often finds no trace of tuberculosis and the veterinarian must search carefully to discover the little knots on the lymph glands, frequently the only pathological signs.

These are, especially in thè retro-pharyngeal, mesenteric, mediastinal and bronchial glands. The majority of reacting cows have simply latent tuberculosis. In time this may develop further in many cases. But my investigations have shown that such tuberculosis can often remain without development for years, and exert no influence on the general health or the functions of the animal. We cannot conclude from this observation that an animal which reacts with tuberculin is thereby condemned to advancing disease, to wasting away and final death. The reaction simply indicates the possibility of such a result. Whether or not it will prove a reality we do not know.

We must remember that the reaction gives very little light as to how far tuberculosis has advanced in the body of the animal. The intensity of the reaction is not in proportion to the amount of the tuberculous deposits. It would be nearer correct to assert that these two factors vary inversely to each other. A strong reaction is most often noticed in slight cases, while cattle which have been affected a long time frequently react only slightly or not at all. But this is by no means always true. As will be shown farther on, many cases of slight tuberculosis show no reaction. The latter are usually old cases. From the degree of the reaction, conclusions as to the development of the disease must be drawn with great care.

The question arises, how much dependence can be placed on tuberculin as a diagnostic agent? A. Eber[18] has recently made 563 inoculation tests, in various places, and states that dissections corroborated the tuberculin diagnosis in 489 cases, and failed to do so in 74 instances, this amounts to 86.86 per cent and 13.14 per cent respectively. In Denmark similar, though better, results have been obtained. 515 dissections showed 50 false tuberculin diagnoses i. e. 9.7 per cent.

The false diagnoses are of two kinds, either the animal reacts with tuberculin without showing a trace of the disease at the autopsy, or the autopsy shows tuberculosis where the tuberculin failed to react.

As tuberculous deposits found in reacting animals are often so very insignificant, one cannot lay particular significance on their reported absence, unless entire confidence is to be placed in the experience and care of the investigator. Knots from the size of a needle's head to that of a pea in a hidden lymph gland surrounded by fatty tissue, may be overlooked even by those of much experience. In the case of animals intended for the butcher, all of the parts cannot be carefully investigated and doubt therefore always accompanies a negative result. From my personal observation I know of three cases of typical reaction in which it was impossible for me to discover tuberculous deposits. In two of these the animal was entirely healthy.[19] The third was a fifteen year old cow. This animal stood among those which reacted at Thurebylille and had reacted every year from 1892 to 1895. She suffered from pyelitis and chronic fibrous nephritis. In the diseased organs no tubercle bacilli could be discovered, but streptococci and other bacteria were present. This is the only case within my observation in which apparently the reaction was to be explained by the presence of a non-tuberculous chronic disease. Such cases are often mentioned in literature, but I wish to call attention to the fact that an animal suffering from cancer or actinomycosis very often suffers from tuberculosis at the same time. In such cases small tuberculous deposits may easily escape notice.[20]

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[18] Deutsche thierärztl. Wochenschr. No. 26.

[19] Compare "La lutte contre la tuberculose en Denmark" p. 30. The one animal was a young cow and the other a 6 mos. old calf. This animal was butchered 3 mos. after the inoculation. It might be possible that the infection had recently taken place and that thus tuberculosis was not yet visible to the naked eye.

Although the negative autopsy results, in the case of reacting animals, may be doubted, it is true that tuberculosis is frequently found in an animal which has not reacted. Very often one finds such animals far advanced in disease, but oftener yet with very insignificant calcified deposits[21] (especially in the lymph glands) frequently so old and so completely impregnated with lime that one involuntarily inclines to believe a cure has taken place.

The absence of reaction in those forms of tuberculosis has certainly very slight significance in the practical application of tuberculin. It must be acknowledged that in the division of a tested herd, it would be possible to include in the healthy division a few animals with tuberculosis in the form of small lime impregnated knots in a lymph gland. Such animals, however, are not infectious at that period, and probably would never become so. But if the disease should develop in an unsuspected manner, the animals would in all probability react with a repetition of the test in the following year.

Much more difficult are those cases in which there is an absence of reaction in far advanced tuberculous animals. But in such it will probably always be possible to discover the disease by the usual clinical investigation.

It has often been proved that repetition after a short time can call forth an indifference so that only a weak reaction, or no reaction appears.

Apparently a single tuberculin reaction can suppress for a year's time the susceptibility of an animal for this reagent. The reacting division at Thurebylille, I have tested annually since the beginning of the experiment in the year 1892. To my surprise, I found at the time of testing in '93 that the reaction was absent in about 20 per cent of the animals. In order to ascertain whether this was caused perhaps by the cure of the tuberculosis, four of the animals were butchered and very closely studied. They all had tuberculosis. In three it was very slight and of long standing.[40] The fourth was tuberculous to a significant degree and showed no signs of disappearing.[41] I therefore do not venture to draw from these observations the conclusion that those animals which fail to react one year after a typical reaction are to be regarded as cured. In many cases this conclusion would perhaps be justifiable, but as it cannot always be the case I consider it advisable to look upon the animals which have once shown the typical reaction as suspicious, and to leave them in the reacting division. At the repetition of the test in the spring of 1894, the reaction failed again in about 20 per cent of the cases. For the most part these were the animals which had not reacted in the previous year. Individuals among them showed slight reaction. Several which had reacted twice before did not do so this time. The result of the spring test in 1895 was still more significant. Of 69 suspected animals 21 did not react and nine did so only doubtfully. In the case of 15 of these animals the reaction had previously failed either in one or in both of the previous years. These observations are certainly very peculiar and will with continued observation perhaps yield an interesting explanation of the course of bovine tuberculosis.

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[20] Here belong the observations, communicated by me, in XXI. Vol. page 438 of this Journal.—*Johne.*

[21] Among the animals which were separated from the healthy division at Thurebylille, I have seven such cases. These animals were tested from two to six times at intervals of six months without having reacted. In the post mortem examination of old cows which we had injected in order to control the diagnostic power of tuberculin before its shipment, Mr. Stribolt has often made the same observation.

[40] a. (2 1-2 years old) reacted to 40.3° May 1892, while the temperature in two tests in May and July 1893 did not exceed 39°. The dissection in Aug. 1893 showed

Though I have advised the veterinarians not to test again the isolated reacting animals because I feared that the eventual failure of the reaction might prove confusing, still reports of such repetition have been returned to me. Of 144 tuberculous animals, retested after one year, eleven (7.6 per cent) did not react the second time· Such cases are therefore not so frequent elsewhere as they were at Thurebylille.

The fact that the repetition of the tuberculin test, especially after a short time, yields a result different from the first has a certain practical significance. When cattle owners who possess healthy herds must purchase new animals, they should be advised to test the cattle with tuberculin before admitting them to the stable, or to purchase them on a guarantee that such test has been made. In spite of all foresight there is still the danger that tuberculous ani-

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a calcified bunch of nut size and a pair of smaller similiar ones in a mediastinal gland.

b. (12-years old) May 1892 temperature rose to 40.8°, May 1893 to 39.8°, July to 38.9°. The dissection in Aug. 1893 showed in the lungs three ulcerated deposits of the consistency of soft cheese, lying apparently in enlarged bronchia.

c· (3 1-2 years old) May 1892 the temperature rose to 40.6°; May 1893 to 39.4°; July to 38.8°. The dissection in Aug. 1893 showed a cement like mass of pea size in one bronchia, also an equally large calcified bunch in one bronchial gland.

[41] (Four and a half years old cow) May 1893 the temperature rose to 40.8°; May 1893 to 38.9°; July to 38.9°. A dissection, May 1893, showed a small lime bunch in a mediastinal gland and a similar one in a bronchial gland. In the lung an almond sized cheese like bunch and a pea sized bunch of cement character, partly consisting of young whitish gray tissue; also single pearl bunches on the corresponding part of the pleura.

mals may be purchased, and this may be because of failure to react through "indifference." Indeed, a pure deception might be practiced by the seller who could intentionally cause a tuberculin test to be made shortly before the sale. A protection against such danger may easily be established by requiring that every reacting animal shall be provided with a permanent mark. Such a requirement is, however, scarcely practicable at the present time, because it would cause the cattle owners a pecuniary loss which, in my opinion, would bring the entire tuberculin question into discredit. Fortunately, the danger is not so very great. The failure of the reaction on repeating the test is by no means constant even when a few days intervene.[42] Intentional deception could therefore be practiced to no great extent. The very cautious cattle owner could hold his newly purchased animals apart from the healthy ones, until an additional test had been made.

From the uncertainty in the action of the tuberculin, established in various ways, we must necessarily conclude that the tuberculin test is not to be regarded a certain legal proof; for this we have only, first, the evidence of the tuberculous bacilli, secretions, exudations, or extirpated tissues from living animals, and also, positive results from inoculation experiments with such materials; and second, dissection. Clinical investigation, stethoscopy, proof of swollen retropharyngeal lymph glands, of a laryngeal tumor projecting forward between the shield and ring cartilages, rectal exploration with proof of hard tumors in the mesenteric glands, the ovarian ducts, the uterus, on the peritoneum, etc., can in certain instances furnish a probable diagnosis. In such cases there still remains the tuberculin injection. This diagnosis may be considered sufficient to prove tuberculosis, but the tuberculin reaction alone gives, in my opinion, no sufficient proof of the presence of tuberculosis. The negative result from a tuberculin injection yields still less absolute proof of the absence of tuberculosis.

We will now consider the following question, a very important one in the application of tuberculin, viz: Can the reaction produce a worse condition in tuberculous animals than before existed? Hess emphatically states that it can, and on this account he earnestly warns against its application.[43] My attention has been directed to this question from the beginning. In my first publication on tuberculin injection [44] I reported two cases in which acute miliary tuberculosis was proved in two high grade tuberculous cows several weeks after the tuberculin injection. I then stated my suspicion that perhaps the tuberculin injection had some connection with this just as is often supposed to be the case in human practice. With my present very large amount of material for observation at hand, I may express the following opinion: Such an acute development of tuberculosis as a result of tuberculin injection is to be feared only exceptionally and then in cases of advanced tuberculosis. *It must not be forgotten that acute miliary tuberculosis by no means rarely accompanies an advanced tuberculosis of long standing.* It is therefore impossible to offer strict proof of the causal connection with the injection, and only oft repeated observation could make this probable.[45] In support of my view I offer the following: In the course of the last three years I have made careful post mortem examinations of 83 tuberculous animals which have been removed from my experiment farm, Thurebylille. Among these were 18 (or strictly speaking 23) high grade, tuberculous animals. I have been able to prove miliary tuberculosis in only 4 of these. Among the others which showed less developed tuberculosis, I have never found miliary tuberculosis, and with very many I have never found any sign of a more rapid development of the process. On the contrary it has been proved that the disease was restricted locally, often for years, in spite of yearly repeated injections. Dissections were made at very different periods after the injections. In 17 cases from 4 to 12 days after the last test. In all of these cases earlier tests had been made, months or years before. In 28 cases the injection took place from 19 days to 2 months before the butchering. In three of these cases earlier injections had been made. In 38 cases from two and one-half months to one year intervened between the last injection and the dissection. Dissection gives the best explanation of this question, but a clinical observation, continued for years, of a herd tested with tuberculin can render very essential aid. If Hess' opinion is correct, it is to be assumed that tuberculosis must take an unusually vicious course in such herds, but this I have been unable to prove. At Thurebylille there has existed for three years a reacting division, consisting originally of 131 head and now of 69. Although these animals are yearly tested, and although most of them react every year, the division certainly appears to be made up of healthy animals and the farm inspector has expressed the decided opinion that the tuberculosis in this division is no more developed than at the beginning of the experiment. The testimony of many owners of large herds of cattle which have long ago been injected is to the same effect. I will adduce statements from several. A farm tenant whose cattle were injected 20 months previously, when 82 per cent of the grown animals reacted, wrote me recently as follows: Only two cows from the division of 100 head had been sold as decidedly tuberculous. The majority appeared afterwards, just as before, entirely healthy. The fat animals which had been slaughtered had been pronounced healthy by the butchers. Another farm tenant with a herd injected in 1894 had not been obliged to remove a single animal from the tuberculous division numbering 70 head. A large farm owner in Jütland stated in September that he had traced no undesirable result from the injection. His herd of 350 had been injected in February and about 75 per cent reacted. Similar answers have been given by other owners and veterinarians.[16]

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[42] Compare Malm. Om Tuberkulin pp 39-42 (Kristiania 1894) one cow reacted distinctly on the 27th of Oct., on the 5th, 17th, and 20th of Nov., and in addition, with small doses slightly (on the average 1°) on the 30th of Oct., 2d, 7th, 10th, and 13th of Nov.

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[43] "It appears to me a very great risk to subject entire herds of cattle breeding animals and calves intended for breeding, milch cows in milk cure establishments and other animals, to the tuberculin test. By this procedure, the tuberculosis which in many animals is in a dormant state is aroused and made immediately dangerous. The introduction of acute miliary tuberculosis greatly weakens the health of the animals and in the majority of cases hurries them to an untimely slaughter which, as is well known, is very unprofitable to the owner." Landwirthschaftl. Jahrbuch 1894 VII. p 404.

[44] Berliner Thieraerztliche Wochenschrift 1891. Tidskrift for Veterinaerer 1891.

[45] This view I fully indorse, and do so supported by experience gathered from material forwarded me twice weekly, from the Dresden slaughter-house.—*Johne.*

On a large farm, on which before the injection, tuberculosis had appeared in a vicious form, the owner had the impression that the severe cases had afterwards become more numerous. He had, however, not suffered severe losses, and eight months later the large reacting division by no means made a bad impression. Finally, it is to be noticed, that tuberculin has been employed on a large scale in Denmark for years, and still the demand from farmers constantly increases. This could certainly not be the case if the injections were generally followed by bad results.

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We have now found that in tuberculin we possess, if not an absolutely infallible, still an excellent means for recognizing tuberculosis; and that its application is not connected with any particular danger. There still remains the question: How may this material best be

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16. A veterinarian who had injected 600 animals, among them a herd of a large farm 18 months previously, expresses the belief that the injection has produced in no single case an unusually rapid or vicious course of tuberculosis. In spite of a demand made months ago, I have received thus far no report from any veterinarian of an undesirable result.

employed against tuberculosis? It is of course to be understood that we must inoculate the suspected herd and separate the healthy from the reacting animals.

But what shall we do with the latter? In most European states a compulsory and quick butchering of all these animals is out of the question,[47] the number of the reacting animals is so very large. In France, the government will shortly place before the Chambers, a bill planned by Nocard with the following provisions: All cattle which show clinical signs of tuberculosis, and all which in addition to suspicious clinical symptoms, show the tuberculin reaction, must be butchered. One-fourth of the meat value is granted the owner in case of confiscation. All cattle suspected of being contagious i. e., such as have lived with tuberculous cattle, must be subjected to the tuberculin test. The reacting animals must be butchered within one year. If, during this period they show clinical proof of tuberculosis they must be killed immediately. For the meat, when confiscated, the owner receives half price, as meat, if the animal has shown no clinical proof. Under special circumstances, the minister can grant an extension of the observation period.

France is a rich country and for that reason tuberculosis does not appear to be widely spread there. This method may be practicable in France, but in most other countries its execution would be scarcely conceivable. But I consider the requirement of killing the reacting cattle within a year's time too rigorous, at least in countries in which cattle are chiefly held for milk production. The large majority of reacting animals, are indeed, only slightly tuberculous. According to my Thurebylille observations they can remain for years fully capable of accomplishing their work, and with many of them, the tuberculosis probably remains wholly localized for the entire life or even a cure may take place. Why, therefore, should the owner be required to butcher perhaps a hundred of his best cows? In milk producing countries it has long been attempted to establish a race of great milkers. In recent years particular attention with us has been paid to breeding only from such cows as furnished milk with a high percentage of fat. It has been done because this most valuable quality seemed to be hereditary. Should now the work thus accomplished be wholly destroyed? The French requirement would mean for many cattle owners nothing less than financial ruin.

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[47] In the North American State of Massachusetts, such a plan was really set on foot in the year 1894. The aim was to test all the animals with tuberculin, and to kill those which reacted. All cattle imported from other states were to be held in quarantine until the tuberculin test could be made on them. (Report of the board of Cattle Commissioners, Mass., S. M. Fadyean. Journal of Comp. Path. Therap., June 1895.) Whether or not this drastic measure can really be carried out is a question.

Therefore for milk yielding countries I prefer, for the present, to recommend the less radical method which I have introduced into Denmark. This consists of the following features: First, to inoculate the herd with tuberculin. Second, to separate the reacting animals, as far as possible, from the non-reacting. Third, to kill the evidently sick animals, either at once, or after rapid fattening. Fourth, to rear the calves of the cows which react, but otherwise appear healthy or at least only slightly attacked. Fifth, to remove the same immediately after birth from the infected stable, place them in the healthy division and protect them from farther infection especially from milk feeding. Sixth, to carefully disinfect the stable: and Seventh, to inoculate with tuberculin the animals of the healthy division once or twice yearly.

The last precaution is taken to permit the quick removal from this division, of animals which in spite of previous precautions appear to be infected.

This method rests upon the assumption, first, that infection is the single cause of tuberculosis, and second, that the germs are not present everywhere, but that infection is caused by the continued living together through a long period of time with tuberculous cattle, and further by the rearing of calves on raw milk from tuberculous cows.

I venture to advise the rearing of calves from cows which react, but are apparently healthy, because I am convinced that the *larger majority of such calves are really born healthy.* This conclusion may be drawn from the following figures concerning the age of tuberculin inoculated cattle in Denmark:

	Under 6 months		About 1 year		About 2 years		Grown	
	healthy	reacting	healthy	reacting	healthy	reacting	healthy	reacting
No. of Cattle	6,449	1,181	7,988	3,325	5,310	3,611	12,891	12,548
Per Cent	84.5	**15.5**	70.6	**29.4**	59.5	**40.5**	50.7	**49.3**

The table shows in a perfectly clear way the relative health of the youngest class and the gradual increase of the disease in the following years. Tuberculosis is thus, as a rule, not a congenital, but an acquired disease. It may be asked, Does then congenital tuberculosis have no part in the spreading of the disease? It certainly does, but not a chief part. In another article I shall collect my experience with congenital tuberculosis. Here I only state that evidently this form is not a very rare one, as it has previously been believed to be. I have personally and carefully investigated 31 cases of tuberculosis in the fœtus and in new-born calves. In most of these cases there was very slight development.

Therefore this disease would evidently have exerted at first no harmful influence on the general condition of the health and life functions of the animals. Generally there were found only a few small lumps in the liver, somewhat larger, cheeselike, and calcified lumps in the portal, mediastinal and bronchial glands, and occasional single small lumps in the lungs; rarely in the spleen or other organs. One often meets in large calves and heifers tuberculous changes whose origin is in all probability to be traced to a fœtal infection. The chief point is, however, that the principal form of fœtal tuberculosis, that which depends upon placental infection, will only arise in cases in which the cow suffers generalized tuberculosis. The bacilli must have circulated in the blood of the mother in order to enter the placental vessels of the fœtus. Fortunately the larger majority of tuberculous cows do not suffer from generalized tuberculosis, and by far the larger number of apparently healthy cows which betray the disease only through the tuberculin action, will bear, therefore, only healthy calves. *The tuberculin reaction of the cow alone gives no basis for suspecting the health of the calf.* On the other hand, I do not doubt that a certain number of high grade tuberculous cows really bear tuberculous calves. The old practitioners are, therefore, to this extent right, when they regard it as inadvisable to raise calves which are born of "tuberculous" that is, apparently tuberculous cows.

The bull probably only rarely transmits tuberculosis to the fœtus (the ovum) without infecting the cow at the same time. Aside from cases of local tuberculosis in the masculine sexual organs, it is true even of the bull that a virulent quality of the seminal fluid is only to be feared when the animal suffers generalized tuberculosis. Most tuberculous bulls which suffer merely from latent tuberculosis localized in a few lymph glands or in the lung will certainly not produce a fœtal tuberculosis.

The inheritance of a *disposition* is often feared. The possibility of an hereditary disposition cannot be disputed, but at present we know nothing of this in cattle.[48]

It may appear in time that certain families are especially receptive, but cases thus far studied can be just as well explained by the more or less favorable opportunity for infection. There is at least no reason to assume that a calf whose father or mother suffers from accidentally acquired tuberculosis has thereby acquired an increased disposition for the reception of tuberculous bacilli or offers a more favorable nutritive soil for the multiplication of them. Finally the disposition may be ever so great, but it can play no practical part if we are in condition to avoid infection.

We are sufficiently acquainted with the danger of infection when healthy and sick live together. This is generally in the stable, more rarely in the pasture, and is accomplished in various ways, by infected air, water, fodder, etc. I wish to call attention particularly to the probably still greater danger from feeding milk to calves. Although the milk of the majority of tuberculous cows is fortunately not dangerous, still among a large number of tuberculous animals there would be some either with tuberculous udders or so advanced in the disease that their milk, even without visible disease of the udder would be infectious.[49] There is therefore the possibility in many infected herds, that the calves may be infected by feeding raw milk. Of course other animals, as pigs, horses, etc., are subject to like danger.

Proof that this very often happens is shown by experience obtained in Denmark as to the location of tuberculous infection of calves which had been killed after a tuberculin reaction. Three years ago I was able to mention in a Danish report[50] that among 35 dissections of such calves, 24 cases of tuberculosis, evidently from feeding, were found. By this I mean tuberculosis was found either alone or in its oldest form in the retro-pharyngeal or mesenteric lymph glands and occasionally also in the intestinal wall. The numerous dissections which I have made since then or which have been sent me by veterinarians have given similar results. As these calves were fed almost entirely with milk, this food was doubtless the source of infection.

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[48] At Thurebylille the herd consists of several different families which all belong to the red Danish race. I have investigated as to whether a difference in the frequency or in the virulency of tuberculosis dependent upon family differences might be detected, but thus far without result.

[49] I have tested the milk of 63 cows in advanced tuberculosis. This has been done by intra-peritoneal inoculation of guinea pigs and rabbits. I found 9 cases, i. e., 14 per cent, to be virulent—Rep. of the Nat. Hygienic Congress, London 1891, Vol. II. p. 195. Und Word. Med. Arkiv. Bd. XXIII. Nr. 25.

[50] Ugeskrift for Landmänd 1892.

In the case of swine which are largely fed with skimmed milk, whey, or butter-milk, the "feeding turberculosis" takes an important part.

Tuberculosis in horses is not rare in Denmark, doubtless because of the extended use of milk in fattening young horses intended for market. This usually appears as "feeding tuberculosis," with intestinal ulcers and very large deposits in the mesenteric glands, sometimes also in the peri-pharyngeal glands, or with secondary deposits in the lungs.

Tuberculosis investigations have made it highly probably that the coöperative dairies often contribute to the spread of the disease. The patrons receive in return skimmed milk for feeding calves and swine. It is understood of course that they do not receive their own milk but a part of the mixed milk. In case the milk of another patron comes from a tuberculous cow the danger is at hand that in this manner the disease may be communicated to a healthy herd. That this actually happens is proved by the common observation that all grown cattle of a herd may be found healthy, while various calves and heifers react. Fortunately skim-milk is almost everywhere sterilized before being distributed, but it is frequently not heated to a sufficiently high temperature. Since I called attention to this danger which is involved in the otherwise useful coöperative dairies these conditions have gradually improved. I hope it will not be long before all skim-milk will be heated to 85° C (185° F) before being used. From the observations described it must be apparent that infected milk has much to do with the spread of tuberculosis. By cooking or warming at high temperature, sure protection may be easily obtained. The calf, however, can scarcely dispense with the colostrum during the first day of its life, but from the second day, cooked milk is easily digested. At Thurebylille, I have fed all calves very successfully with cooked milk from the second day on. The colostrum is warmed to 65° C (149° F). This temperature does not, indeed, kill tubercle bacilli, but weakens somewhat their virulence. Not much importance is laid on this heating of the colostrum. Probability of an infection through the use of the raw material for one day is evidently not very great. Moreover in this way a tuberculous cow can only infect one calf and that her own, while later a single tuberculous cow can infect many through mixed milk.

Collected evidence has abundantly proved that by following the simple rule, to feed calves only with cooked or highly pasteurized milk gives the very best results. On farms where this method has been used all calves were healthy even where tuberculosis had widely spread among the grown animals.

The frequently mentioned Thurebylille experiment I shall now describe more fully. This farm is rented by a company of Seeland farmers who have attempted to raise a good class of milk cows of the red Danish race. Losses from tuberculosis were suffered and although these were not great, my assistance in the matter was asked. In 1891 when the inoculation test with a part of the herd had shown that the disease was quite widely spread, I conceived the idea of carrying out an experiment at this place. The object of this was to ascertain whether it was possible in the manner often mentioned to gradually change a tuberculous herd into an entirely healthy one. This was to be done with the breeding material already at hand, so as not to destroy what had already been accomplished, in establishing a superior herd of cattle. The local relations were unfavorable in that they did not permit the removal of the reacting animals far from the healthy ones. It would be much easier of course to guard healthy animals against contagion if they could be placed in their own stable at a considerable distance from the others, and if possible on an entirely separate farm. But it was my task to prove that a successful result could be obtained under the unfavorable circumstances which exist on most farms.

The stable at Thurebylille is a so-called square stable; i. e. the cows are placed in rows across the stable, the heads of every set of two rows turned toward each other. Between such rows is a fodder passage with two fodder troughs which, however, are not used for water this being furnished in a trough kept full by a feed pipe. The manure passages extend across the stable and the manure is passed out through a series of doors in the walls. At the end of the stable is connected a long calf-stable provided with a number of large and small boxes.

The separation of the herd into two divisions had to be made by erecting a wooden partition from floor to ceiling across the stable. This was tightened by covering one side with building paper. The wall was made so that it could be moved without difficulty whenever an enlargement of the healthy division should be desirable. For the reception of the healthy animals that part of the stable connected with the calf-stable was taken. This then formed an integral part of the space allotted to the healthy division. Care was observed to use different implements in the two divisions.[60] Beside this each division was provided with its separate stable-hands.

The entire herd of 208 head was inoculated in Apr. 1892. About 80 per cent of the milch cows, about 40 per cent of the bulls, and about 40 per cent of the calves and heifers reacted. Although the herd had in general a healthy appearance and the losses caused by tuberculosis were by no means considerable, here, as in other large herds of milch cows, the disease proved to be widely spread. The reacting calves were immediately butchered, and the remainder of the herd was separated into two divisions which, during the summer, were pastured some distance apart. The entire stable was then carefully disinfected and this operation was afterwards repeated every spring. The cows of the reacting division, which during the year showed noticeable clinical evidence of tuberculosis, were immediately butchered. It was then decided to inoculate the healthy division twice yearly, just before and after pasturing. This was done in order to separate animals which, in spite of the division, appeared to be infected.

All female calves and several males, even those of the reacting division were raised, but immediately after birth, the latter were removed from the infected stable and placed in the healthy division. From the first I feared the possibility of a frequent appearance of fœtal tuberculosis, and it was therefore decided to inoculate the calves with tuberculin very shortly after birth. Up to the making of this test they were kept in little rooms made by dividing the calf boxes. The inoculation was conducted during the course of the winter at intervals of from 4 to 6 weeks, so that on each occasion the calves born in the meantime were injected. This precaution proved to be superfluous for thus far only two calves have been found to be born with tuberculosis.

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[60] To this point I wish to direct especial attention. The precaution seems to be self explanatory and yet it is just here that the farmers are most often at fault.

The reacting division, as I have before mentioned, was inoculated every spring; but this operation had nothing to do with the real plan of experiment. It was done for purely scientific reasons. All, or nearly all, cattle which were removed from the herd including overtime and aborting cows, young and old animals, those not well developed, etc., were butchered at the Copenhagen slaughter-house, and carefully examined by me or in a few cases by my assistant.

The result of the experiment appears from the following figures:

	Reacting Division.	Healthy Division.	Reacting Animals in the Healthy Division.
April…………	131	77	—
October………	—	77	−7
May…………	90	103	−10
October………	—	107	−1
April…………	81	122	−2
October………	—	119	−1 (?)
May…………	69	136	−2 (1) + 1 (?)
October………	—	132	−2 (2)

(1). One calf had insignificant inborn tuberculosis, one cow had a few calcified knots in one mediastinal gland.

(2). One three year old cow had shown reaction even in May: she was butchered, but I found no definite tuberculosis, only two knots of the size of a pin head in which tuberculous bacilli could not be detected. The diagnosis therefore remains doubtful.

The first year's result was thus unfavorable, for about 10 per cent of the animals of the healthy division reacted on the repeating of the test. This may be due partly to lack of care in making the division the first year.*

But I believe that the chief cause was unfavorable local conditions. In order to enter the healthy division it was necessary to go over a walk over which the dung of the reacting division was carried out. At the time this walk was very poorly paved and therefore hard to clean. Infected particles could therefore very easily attach themselves to the foot-gear of passing persons, and thus be introduced into the healthy division. This walk was later radically improved.

Since October 1893 a result has been obtained which left nothing to be desired, when the local conditions are considered. I wish to call especial attention to the fact that with the exception of two cases of inborn tuberculosis and the one doubtful case at the last test, thus far no animal born in the reacting division* since the beginning of the experiment has later shown itself to be tuberculous. *The practicability of the method is hereby proven.*

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*At the first division of a tuberculous herd it must always be borne in mind that single animals may have acquired germs so shortly before the test that they are not yet in condition to show the infection by a reaction.

At the last test the healthy division consisted of three grown bulls, one two-year-old ox, three yearling bulls, 73 cows, 17 two-year-old heifers, 31 yearling heifers, and four small calves. The number of milch cows is thus at present larger than that of the reacting. Most of the healthy animals were born on the farm, only a few were purchased during the first years. These animals were of course tested with tuberculin before being received. The experiment at Thurebylille has been conducted at considerable cost to the state on a special appropriation. The expenses have been only partially due to measures necessarily attendant on such an experiment, such as for instance. changes in stable arrangement, the wages of a special man for feeding the healthy division, etc. The frequent inoculation of young calves occasioned some expense. This might be omitted. A large part of the cost was due to my dissections of the butchered cows; because of the unreasonable advantage which the butchers always took in paying only a very low price whenever it was demanded that the animals be subjected to close examination. On other farms, where the experiments have a purely practical object, the expenses are of course much less. In comparison with the losses which tuberculosis causes from year to year they are insignificant especially when the investigation itself is entirely or nearly free of cost as in Denmark.

The division of the stable by a wooden partition costs but little. More radical changes cause greater expense. The experiment at Thurebylille has shown that such are not absolutely necessary, but very complete separation would better insure quick success, and under certain circumstances it would perhaps pay to make greater sacrifice in the beginning. In Denmark, the condition on which the free tuberculin test is offered is that the owner promises to separate the healthy from the reacting animals. It may be of interest to notice what is demanded in this respect. The healthy animals must be placed in a separate room. This may be obtained by placing in the stable a wooden partition reaching from floor to ceiling, like that described on page 23 in Thurebylille. It has even been necessary to permit a door to be placed in this wall to accommodate the fodder passage or the dung passage or even both. Under such circumstances a complete exclusion is very difficult to maintain, but the owner is always told that, for his interest, the separation must be as complete as possible. If a door be placed in the wall it must always be carefully closed after being used.

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*The mothers of these animals and the fathers of most of them had tuberculosis. Two healthy bulls were at first placed in the reacting division in accordance with the wish of the owners. As was to be foreseen, both reacted within a year. They remained apparently healthy and served constantly in the division. One was butchered this autumn (1895) and had insignificant tuberculosis in one lung and in the mediastinal and bronchial glands.

With reference to the stable-workers, the owner is always told that it is far better to have entirely different persons for the two divisions; but it is very difficult to attain the ideal. On large farms, a near approach is made, but the desirable is seldom reached. I believe, however, that the danger of infection through persons is not very great. It can doubtless be very much lessened by following the simple rule to visit first the healthy division, and to wear there separate shoes and outside garments.

* * * * * * * * * *

In Denmark the rules observed in subduing tuberculosis are not guarded by the police. The state wishes simply to lend a helping hand to the farmers in their struggle for freedom from the evil. The chief task, therefore, is to give the owners a correct understanding of the nature of tuberculosis and to explain the principal means of contagion. When the farmer correctly understands these matters he will succeed in the struggle, although local conditions may not favor a desirable separation. While I have not insisted very strongly on the last requirement I have done so knowingly and because I see more chance for success when the farmers begin their struggle hopefully. After having attained a few good results, they will doubtless be more willing to make larger sacrifice in order to win greater success.

The larger majority of the tuberculin tests accomplished in Denmark have only been undertaken during the last year. It is therefore too early to look for great success. However, in many places such has most certainly been attained. Many small herds have, after the removal of the reacting animals, been entirely freed from the disease. Where two divisions are kept on the same farm, the test made after the first year has shown, as a rule, a decided increase of the non-reacting animals. There are very naturally many cases in which the directions are so carelessly followed that the success has only been moderate; but even in these cases it is not infrequently reported that the owner now recognizes his errors and will correct them. On various large farms where young animals of different ages are kept in separate yards, extraordinarily favorable results have been obtained. In these cases, it may be definitely assured that in a few years the old affected herd will be replaced by entirely healthy animals. I offer the following as an example of experiments conducted according to the Thurebylille method, which has resulted very favorably. In Jan. 1894, on a certain farm the entire herd consisting chiefly of black variegated Jütland cattle was inoculated. One hundred and thirty-nine reacted (82 per cent of the grown animals) 86 were healthy. In Dec. 1894 the entire healthy division, which through the birth of calves had increased during the year to 114, was again inoculated. Eight animals reacted, but here in this year the separation was not accomplished carefully enough. Upon repeating the test in May, 1895, the healthy division contained 117 head, of which one animal showed a typical, and one a doubtful reaction. At the last test in Nov. 1895, the division then containing 140 head, only one reacted.

The struggle against bovine tuberculosis must of course be of several years' duration, but it can and must be crowned with victory. In this struggle tuberculin has yielded an invaluable service. Only with the aid of this agent can we determine the actual extent of the disease. On the basis of the tuberculin investigations we are already in position to establish a rational plan of operation, and by this means alone can we retain the advantages gradually won; but the contest is well worth the pains. The conquest of bovine tuberculosis promises not only large economic profit, but also the annihilation of an important source of human tuberculosis.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 42.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.
II. ANALYSES OF LICENSED FERTILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1896.
III. NEW LAWS FOR THE REGULATION OF THE TRADE IN COMMERCIAL FERTILIZERS IN MASSACHUSETTS.

OCTOBER, 1896.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1896.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

HENRY H. GOODELL, LL. D.,	*Director.*
WILLIAM P. BROOKS, B. SC.,	*Agriculturist.*
GEORGE E. STONE, PH. D.,	*Botanist.*
CHARLES A. GOESSMANN, PH. D., LL. D.,	*Chemist* (Fertilizers).
JOSEPH B. LINDSEY, PH. D.,	*Chemist* (Foods and Feeding).
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
LEONARD METCALF, B. S.,	*Meteorologist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*
RALPH E. SMITH, B. SC.,	*Assistant Botanist.*
HENRI D. HASKINS, B. SC.,	*Assistant Chemist* (Fertilizers).
ROBERT H. SMITH, B. SC.,	*Assistant Chemist* (Fertilizers).
EDWARD B. HOLLAND, B. SC.,	*Ass't Chemist* (Foods and Feeding).
ROBERT A. COOLEY, B. SC.,	*Assistant Entomologist.*
JOSEPH H. PUTNAM, B. SC.,	*Assistant Horticulturist.*
BENJAMIN K. JONES, B. SC.,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

HATCH EXPERIMENT STATION, Amherst, Mass.

DEPARTMENT OF CHEMISTRY.

C. A. Goessmann.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

WOOD ASHES.

219-223. I. Sent on from North Amherst, Mass.
II. Sent on from South Deerfield, Mass.
III. Sent on from Foxboro', Mass.
IV and V. Sent on from Danvers, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	13.58	19.50	12.41	5.64	10.60
Potassium oxide,	3.74	7.00	6.42	5.36	7.58
Phosphoric acid,	1.25	1.55	2.64	2.08	1.96
Insoluble matter,	—*	12.24	7.03	14.63	9.42

WOOD ASHES.

224-228. I. II. and III. Sent on from Hadley, Mass.
IV. Sent on from Sea View, Mass.
V. Sent on from Wollaston Heights, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	9.19	6.35	4.02	5.81	9.97
Potassium Oxide,	6.52	5.40	5.00	7.36	3.64
Phosphoric acid,	2.09	2.00	1.50	1.53	.52
Insoluble matter,	7.92	9.00	19.02	10.07	12.53

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* Not determined.

WOOD ASHES.

229-232. I. Sent on from North Andover, Mass.
II. Sent on from Westboro', Mass.
III. Sent on from South Amherst, Mass.
IV. Sent on from South Lancaster, Mass.

	I.	II.	III.	IV.
		Per cent.		
Moisture at 100° C.,	.21	7.28	16.83	9.27
Potassium oxide,	4.76	4.54	3.44	4.00
Phosphoric acid,	1.11	1.19	1.35	1.33
Insoluble matter,	55.96	14.71	14.88	22.07

Some fifty samples of wood ashes have been analyzed thus far during the present year. The following statement contains the variations noticed with reference to Potassium oxide, Phosphoric acid and Calcium oxide (lime).

	Lowest.	Highest.
Potassium oxide,	2.96	8.68
Phosphoric acid,	.52	2.64
Calcium oxide,	27.80	42.95

The amount of Potassium oxide varied according to the following percentages:

No. of samples.	Percentage variation.
3	2.50-3.50
8	3.50-4.50
11	4.50-5.50
11	5.50-6.50
10	6.50-7.50
5	7.50-8.50
1	8.50-9.50

The majority of dealers in unleached wood ash guarantee from 4.5 to 6 per cent of potassium oxide. The higher grades of wood ashes are frequently obtained from home sources. It is well to see to it that the quantity of both potassium oxide and phosphoric acid are separately mentioned with reference to their percentage, as our laws require.

233-234. I. Cottonseed hull ashes sent on from Springfield, Mass.
II. Caustic potash solid sent on by a soap manufacturer.

	Per cent.	
	I.	II.
Moisture at 100° C.,	9.45	*
Potassium oxide,	28.80	59.25
Phosphoric acid,	10.80	—
Insoluble matter,	4.38	—

MUCK.

235-236. I. Sent on from West Worthington, Mass.
II. Sent on from East Walpole, Mass.

	Per cent.	
	I.	II.
Moisture at 100° C.,	50.66	53.42
Nitrogen,	.538	.158

MIXED FERTILIZERS.

237-241. I. Sent on from Methuen, Mass.
II. Sent on from Granby, Mass.
III. Sent on from Westford, Mass.
IV. Sent on from Barre, Mass.
V. Sent on from Harvard, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.63	9.10	20.35	8.43	9.70
Potassium oxide,	12.80	10.76	2.08	9.44	10.80
Total phosphoric acid,	10.70	14.40	12.62	9.82	9.62
Available phosphoric acid,	*	*	6.01	5.57	8.52
Insoluble phosphoric acid,	*	*	6.61	4.25	1.10
Nitrogen,	4.88	2.11	1.97	3.10	.11

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* Not determined.

TANKAGE.

242. Sent on from Granby, Mass.

	Per cent. I.
Moisture at 100° C.,	12.85
Phosphoric acid,	13.76
Nitrogen,	4.09

BARNYARD MANURE.

243-245. Three samples sent on for analysis.

	Per cent. I.	II.	III.
Moisture at 100° C.,	70.51	73.74	75.61
Potassium oxide,	.619	.543	.424
Phosphoric acid,	.555	.638	.547
Nitrogen,	.480	.394	.469
Insoluble matter,	6.975	2.260	*

URINE OF CATTLE.

246-249. Nitrogen in Urine of Cattle obtained under different systems of feeding, Amherst, Mass.

I. and II. Morning and evening urine obtained on the same day of first lot of cows.

III. and IV. Morning and evening urine obtained on the same day of second lot of cows.

V. Urine sent on from a Western steer fattening establishment representing the product of an entire day.

	Per cent. I.	II.	III.	IV.	V.
Nitrogen in form of ammonia,	.128	.084	.094	.030	.270
Total nitrogen,	.996	.723	.103	.377	.432

The determinations of the nitrogen in form of actual ammonia were made during the first day after collecting—except V,—which was acidulated with hydrochloric acid before sending on.

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* Not determined.

250. Green coloring matter in brooms.

The color proved to be green oxide of Chromium, a harmless and insoluble substance, and not Paris Green as supposed by the parties who sent the material on.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY No.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT
	Compound Fertilizers.		
4	High Grade Universal Fertilizer,	Packers' Union Fertilizer Co., New York, N. Y.,	Amherst.
7	High Grade Gardeners' Complete Manure,	Packers' Union Fertilizer Co., New York, N. Y.,	Amherst.
11	Meat and Bone,	Springfield Provision Co., Brightwood, Mass.,	Brightwood.
15	Complete Onion Manure,	H. J. Baker & Bro., New York, N. Y.,	Sunderland.
23	Darling & Hubbard Formula,	Bowker Fertilizer Co., Boston, Mass.,	Sunderland.
25	Onion Manure,	Williams & Clark Fertilizer Co., Boston, Mass.,	Sunderland.
27	Wood Ashes,	Monroe, Lalor & Co., Oswego, N. Y.,	Hadley.
28	Complete Manure for Corn and Grain,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
43	Corn Manure,	Mapes' Formula and Peruvian Guano Co., N. Y.,	Worcester.
47	Complete Manure for Top Dressing,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
49	Potato, Hop and Tobacco Manure,	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.,	Northboro.
55	Dry Ground Fish,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
56	Complete Manure,	I. S. Whittemore, Wayland, Mass.,	Wayland.
62	Complete Manure for Vines,	Bowker Fertilizer Co., Boston, Mass.,	So. Sudbury.
64	Wood Ashes,	Monroe Lalor & Co., Oswego, N. Y.,	Northboro.
272	Potato, Hop and Tobacco Manure,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Greenfield.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
4	High Grade Univérsal Fertilizer,	5.95	3.09	.82-1.64	8.00	2.00	.62	10.62	9-15	10.00	8-12	4.91	5-8*
7	Gardners' Complete Manure,	4.42	2.81	2.47.3.29	8.20	1.04	1.65	10.89	10-15	9.24	8-12	9.34	10-12*
11	Meat and Bone,	4.68	7.15	—	—	2.94	6.52	9.56	—	2.94	—	—	—
15	Complete Onion Manure,	9.35	4.96	4.94	3.85	1.80	.50	6.15	—	5.65	4-5	9.92	9.
23	Darling & Hubbard Formula,	9.25	3.60	—	4.85	2.75	2.13	9.73	—	7.60	—	8.02	—
25	Onion Manure,	9.47	3.51	3.71-4.53	4.22	5.12	1.66	11.00	9-13	9.34	8-11	5.94	6-7
27-64	Wood Ashes,	7.20	—	—	—	—	—	1.85	—	—	—	5.16	4.5-7
28	Complete Corn and Grain Fertilizer,	5.10	3.62	3.30-4.12	4.45	3.78	3.77	12.00	8-10	8.23	6-8	6.48	6-7
43	Mapes' Corn Manure,	8.17	3.58	4.5-5.	5.85	3.95	2.10	11.90	10-12	9.80	8-10	6.48	6-7
47	Complete Topdressing Manure,	8.77	4.71	4.94-5.76	1.37	4.86	1.77	8.00	6-8	6.23	5-7	2.56	2.5-3.5*
49-272	Potato, Hop and Tobacco Manure,	11.50	1.84	2-3	7.40	3.89	1.61	12.90	10-12	11.29	9-11	3.48	3.25-4.25
55	Dry Ground Fish,	6.60	8.64	8 10	—	3.48	3.32	6.80	6-8	3.48	—	—	—
56	Complete Manure,	12.06	3.38	2.47-3.30	4.47	8.82	2.50	15.79	12-14	13.29	8-12	4.36	3-4
62	Complete Vine Manure,	7.72	4.46	5-6	4.45	2 73	4.32	11.60	5-7	7.18	3-4	6.12	4-5

NOTE—In the following fertilizers Nos. 135, 152 and 176, manufactured by the E. Frank Coe Co., New York, N. Y., and published in Bulletin No. 40 of this Station, through some oversight credit was not given for the form of Potassium Oxide which was found to be present as Sulphate as claimed.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY NO.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT
	Compound Fertilizers.		
63	Complete Manure for Cabbage and Cauliflower,	Bowker Fertilizer Co., Boston, Mass.,	So. Sudbury.
65	Unleached Wood Ashes,	Allison, Stroup & Co., New York, N. Y.,	Boston.
72	Ground Tobacco Stems,	F. C. Sturtevant, Hartford, Conn.,	Worcester.
78	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Worcester.
84	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
93	Tobacco Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	Hadley.
98	Market Garden Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	Spencer.
108	Odorless Lawn Dressing,	Russia Cement Co., Gloucester, Mass.,	Taunton.
109	Potato Phosphate,	National Fertilizer Co., Bridgeport, Conn.,	Spencer.
110	Lobos Peruvian Guano,	Lucien Sanderson, New Haven. Conn.,	Taunton.
112	Dry Ground Fish,	Russia Cement Co., Gloucester, Mass.,	Amherst.
113	X. X. X. Fish and Potash,	Russia Cement Co., Gloucester, Mass.,	Amherst.
114	Blood, Bone and Meat,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
126	Bone and Blood,	Armour & Co., Chicago, Ill.,	Hadley.
127	Lawn Top Dressing with Plaster,	Mapes Formula and Peruvian Guano Co., New York,	Taunton.
131	High Grade Fish and Potash,	The Wilcox Fertilizer Works, Mystic, Conn.,	Amherst.
148	Dry Ground Fish,	Russia Cement Co., Gloucester, Mass.,	Pittsfield.
189	Bone and Blood,	Armour & Co., Chicago, Ill ,	Williamstown.
293	Odorless Lawn Dressing,	Russia Cement Co., Gloucester, Mass ,	Amherst.
297	X. X. X. Fish and Potash,	Russia Cement Co., Gloucester, Mass.,	Gloucester.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
63	Complete Cabbage and Cauliflower Fert.,	7.60	4.99	4-5	4.60	2.45	4.60	11.65	6-8	7.05	5-6	6.36	6-7
65	Unleached Wood Ashes,	11.61	—	—	—	—	—	.64	—	—	—	—	6.36
72	Ground Tobacco Stems,	13.12	2.00	1.96	—	—	—	1.15	.75	—	—	8.26	7.66
78-84	A. A. Ammoniated Superphosphate,	15.17	2.60	2.47.3.30	8.75	2.60	.95	12.30	11-13	11.35	10-13	2.90	2-3*
93	Tobacco Fertilizer,	12.40	2.92	3.30-4.94	3.75	5.07	2.38	11.20	10-12	8.82	8-10	5.80	5.4-6.48
98	Market Garden Fertilizer,	10.05	2.74	2.47-3.30	1.13	9.07	2.80	13.00	9-11	10.20	7-9	7.04	6-8*
108-293	Odorless Lawn Dressing,	3.15	4.09	3.71-4.53	.56	3.90	5.46	9.92	7-8	4.46	5.5-6.5	7.88	7-8
109	Potato Phosphate,	11.42	2.20	2.06-2.88	.80	5.75	2.07	8.62	8-10	6.55	6-8	8.82	8-10*
110	Lobos Peruvian Guano,	10 57	2.58	2.47-3.30	—	5.84	11.13	16.97	13.	5.84	—	1 38	2.
112-148	Dry Ground Fish,	9.30	8.30	8.24-12.01	—	5.56	6.91	12.46	11-13	5.56	—	—	—
113-297	X. X. X. Fish and Potash,	9.02	2 38	2.06-2.88	5.15	2.25	4.90	12.30	12-14	7.40	10-12	2.10	2.25-3.25
114	Blood, Bone and Meat,	9.17	6.02	6 59-8.24	—	4.24	9.22	13.46	10-12	4.24	—	—	—
126-189	Bone and Blood,	8.60	5.46	5.77-6.59	—	4.63	7.52	12.15	10-12	4.63	5-7	—	—
127	Lawn Dressing with Plaster,	9.05	2.72	2.47-2.88	1.77	3.52	.46	5.75	3.5-4.5	5 29	—	2.46	2.5-3.5
131	High Grade Fish and Potash,	17.07	3.18	3.25-4.25	2.25	4.69	2.41	9.35	6-8	6.94	5-7	4.48	4-6

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
139	Bone, Blood and Potash,	Armour & Co., Chicago, Ill.,	Hadley.
146	Dry Ground Fish Guano.	Wilcox Fertilizer Works, Mystic, Conn.,	Amherst.
151	Pioneer Fertilizer,	Preston Fertilizer Co., Greenpoint, L. I.,	Pittsfield.
147	Complete Fertilizer for Grain,	National Fertilizer Co., Bridgeport. Conn.,	Hadley.
154	Ammoniated Superphosphate,	Preston Fertilizer Co., Greenpoint, L. I.,	Pittsfield.
162	Special Fertilizer for Strawberries and small fruits,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
165	Grass Fertilizer,	Quinnipiac Co., Boston, Mass.,	Westfield.
166	Potato Fertilizer,	Preston Fertilizer Co., Greenpoint, L. I.,	Pittsfield.
170	Grass Fertilizer,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
175	Breck's Lawn and Garden Dressing.	Bradley Fertilizer Co., Boston, Mass.,	Boston.
177	Special Potato Fertilizer.	Parmenter & Polsey Fertilizer Co., Peabody, Mass.	Dighton.
178	Green House Chemicals,	Bowker Fertilizer Co., Boston, Mass.,	Boston.
181	Dry Ground Menhaden Fish Guano,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
182	Imperial Bone Superphosphate,	Henry F. Tucker, Boston, Mass.,	Middlefield.
186	Original Bay State Bone Superphosphate,	Henry F. Tucker, Boston, Mass.,	Middlefield.
187	Read's Standard Superphosphate,	Read Fertilizer Co., Syracuse, N. Y.,	Williamstown.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
139	Bone, Blood and Potash,	6.20	4.08	4.12 4.94	7.28	3.11	1.78	12.17	10-12	10.39	8-10	7.52	7-8*
146	Dry Ground Fish Guano,	8.95	8.75	8.5-10.	—	4.20	3.55	7.75	6-9	4.20	4-6	—	—
151	Pioneer Fertilizer,	9.00	2.64	1.44-1.65	4.00	4.90	6.16	15.06	—	8.90	10-12	1.85	1.75-2.00
147	Complete Fertilizer for Grain,	11.60	3.12	3.71-4.53	3.32	5.60	1.28	10.20	10-12	8.92	8-10	5.96	5-7
154	Ammoniated Superphosphate,	9.60	3.17	2.47-3.30	2.90	5.09	7.01	15.00	—	7.99	9-11	2.44	2-3
162	Special Fert. for Strawb's and Small Fruits,	8.37	2.60	2.47-3.30	4.66	5.94	1.95	12.55	10-12	10.60	9-11	6.20	6-7
165-170	Grass Fertilizer,	7.50	4.03	3.91-4.74	1.72	4.16	2.62	8.50	6-8	5.88	5-7	2.09	2-3
166	Potato Fertilizer,	7.61	3.01	3.30-4.12	5.15	3.52	3.05	11.72	8-9	8.67	8-9	7.72	7-9
175	Breck's Lawn and Garden Dressing,	7.38	4.04	4.12-4.94	1.40	4.38	1.62	7.40	5-6	5.78	5-6	4.96	5-6
177	Special Potato Fertilizer,	7.52	3.08	3.29-4.12	3.12	5.49	1.74	10.35	9-13	8.61	8-11	9.10	7-9
178	Greenhouse Chemicals,	6.82	4.03	4.12-4.94	5.05	1.73	4.82	11.60	5-6	6.78	5-6	4.96	5-6
181	Dry Ground Menhaden Fish Guano,	7.80	6.78	8.24-9.89	—	3.14	5.16	8.30	6.87-9.16	3.15	—	—	—
182	Imperial Bone Superphosphate,	12.95	1.76	1.-1.5	4.65	5.22	1.98	11.85	11-15	9.87	9-11	2.08	1.85
186	Original Bay State Bone Superphosphate,	13.67	1.98	2.	7.05	2.17	2.50	11.72	11-15	9.22	9-11	1.84	2-3
187	Read's Standard Superphosphate,	13.92	1.13	.82-1.65	6.65	2.05	1.22	9.92	9-11	8.70	8-10	4.08	4-6

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
203	Soluble Potato Manure,	Rogers & Hubbard Co., Middletown, Conn.,	Westfield.
213	Crossed Fish and Potash,	Quinnipiac Co., Boston, Mass.,	Westfield.
217	Bay State Potato and Tobacco Fertilizer,	Clark's Cove Fertilizer Co, Boston, Mass.,	Springfield.
226	Tankage,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
227	Fruit Fertilizer,	Rogers & Hubbard Co., Middletown, Conn.,	Westfield.
234	Vegetable Bone Superphosphate,	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.,	Fitchburg.
237	Climax Phosphate,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
266	Dry Ground Fish,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
269	Swift and Sure Superphosphate,	M. L. Shoemaker & Co., Philadelphia, Pa.,	Greenfield.
273	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
274	Tankage,	Bartlett & Holmes, Springfield, Mass.,	Greenfield.
286	Dissolved Bone and Potash,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
287	Lowell Vegetable and Vine,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
291	Lowell Bone Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
292	Superphosphate,	John C. Dow & Co., Boston, Mass.,	Amherst.
301	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Fitchburg.
247	Lowell Bone Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Springfield.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
203	Soluble Potato Manure,	8.10	5.14	5-6	1.55	6.03	3.42	11.00	10-12	7.58	7-8.5	5.58	5-6*
213	Crossed Fish and Potash,	11.92	2.58	3.30-4.12	1.35	5.96	2.74	10.05	6-8	7.31	3-5	4.36	3-5*
217	Bay State Potato and Tobacco Fertilizer,	14.07	1.98	2.06-2.88	4.30	5.77	2.78	12.85	9-13	10.07	8-11	3.14	3-4*
226	Tankage,	15.57	7.20	6.59-7.41	—	5.02	5.75	10.77	9-11	5.02	—	—	—
227	Fruit Fertilizer,	6.10	3.20	2.5-3.00	—	5.31	13.53	18.84	17.5-18.5	5.21	—	11.60	12.5-13.5
234	Vegetable Bone Superphosphate,	13.05	4.86	5-6	5.50	1.39	.76	7.65	7-9	6.89	6-7	6.85	5.94-8.00
237	Climax Phosphate,	13.05	1.23	1.03-1.64	4.17	3.37	3.21	11.75	9-13	7.54	8-11	2.08	2-3
277	Dry Ground Fish,	12.60	8.22	7.41 9 06	—	6.35	4.00	10.35	7-9	6.25	—	—	—
269	Swift and Sure Superphosphate,	14.00	2.52	2.47-4.12	6.30	3.45	3.75	13.50	9-11	9.75	5-6	4.16	4-6
273-301	Ammoniated Bone Superphosphate,	13.27	4.15	2.47-3.30	6.20	5.20	2.12	13.52	10-13	11.40	9-11	2.16	2-3
274	Tankage.	10.02	4.26	—	—	8.48	10.87	19.35	—	8.48	—	—	—
286	Dissolved Bone and Potash,	9.17	2.78	1.65-2.47	—	9.08	4.60	13.68	7-9	9.08	6-7	2.04	2-3
287	Vegetable and Vine Fertilizer,	7.41	3.04	2.47-3.30	—	9.48	3.46	13.94	8-10	9.48	7-8	7.14	6-7
247-291	Lowell Bone Fertilizer,	11.85	2.56	2.47-3.30	—	6.78	4.34	11.12	6-8	6.78	5-6	3.04	3-4
292	Superphosphate,	16.56	2.28	2.06-2.88	2.92	7.90	1.68	12.50	—	10.82	8-10	3.16	3-4

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
303	Four Fold Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Fitchburg.
306	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Fitchburg.
307	Tankage,	Lowe Bros. & Co., Fitchburg, Mass.,	Fitchburg.
308	English Lawn Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Fitchburg.
310	Fertilizer for Gardens and Lawns	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Fitchburg.
311	Plantene,	A. W. Perkins & Co., Rutland, Vt.	Amherst.
314	Soluble Bone and Potash,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
315	Northern Corn Special Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
316	Garden Special Fertilizer	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
317	General Fertilizer	Great Eastern Fertilizer Co., Rutland, Vt.,	Amherst.
318	High Grade Fruit Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
319	High Grade Grass and Oats,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
321	Superior Truck Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
322	High Grade Potato Manure	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
323	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
303	Four Fold Fertilizer,	8.42	1.70	.82-1.65	6.66	3.14	2.20	12.00	11-14	9.80	8-10	1.26	1-2
306	Potato Special,	5.07	2.34	1.65-2.47	7.29	3.20	2.90	13.35	13-15	10.49	9-10	4.36	5-6
307	Tankage,	16.27	4.00	4.-4.5	—	8.30	11.96	20.26	20-21	8.30	—	—	—
308	English Lawn Fertilizer,	5.45	5.09	4.94-5.77	1.05	3.13	1.52	6.70	6-9	4.18	5-7	2.74	2.5-3-5
310	Fertilizer for Garden and Lawns,	8.12	3.13	3.30-4.94	3.37	5.96	4.57	13.90	10-12	9.33	—	6.44	5-6
311	Plantene,	15.92	5.29	5.75	10.42	—	.20	10.57	10.	10.42	9.	6.32	6.
314	Soluble Bone and Potash,	14.25	.20	—	5.22	5.52	1.28	12.02	12-18	10.74	11-15	1.62	2-3
315	Northern Corn Special Fertilizer,	14.50	3.44	2.88-3.88	4.42	4.77	1.43	10.62	9-15	9.19	8-12	2.26	2-3
316	Garden Special Fertilizer,	9.35	4.84	3.30-4.12	5.34	1.72	1.26	8.32	—	7.06	6-8	8.10	8-10
317	General Fertilizer,	14.40	1.11	.82-1.65	6.91	1.86	1.03	9.80	9-15	8.77	8-12	4.08	4-6
318	High Grade Fruit Fertilizer,	13.27	—	—	6.80	4.30	.72	11.65	12-17	11.10	10-14	7.42	8-10
319	High Grade Grass and Oats Fertilizer,	12.97	.16	—	5.15	6.85	1.07	13.07	—	12.00	11-13	1.82	2-4
321	Special Truck Fertilizer,	10 55	3.30	3.29-4.10	5.72	1.76	1.04	8.52	8-11	7.48	7-9	9.18	8-10
322	High Grade Potato Manure,	11.26	2.21	2.05-2.88	7.24	1.71	1.54	10.49	9-15	8.95	8-12	5.86	3.25-4.00
323	Corn Fertilizer,	11.47	3.08	1.64-2.47	7.09	1.79	1.84	10.72	9-14	8.88	8-12	2.30	2-3

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY NO.	NAME OF BRAND.	NAME OF MANUFACTURER.	SAMPLED AT
	Compound Fertilizers.		
325	Extra Bone Phosphate,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Amherst.
326	Potato and Root Crop Manure,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Amherst.
327	Pure Dissolved Bone,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Amherst.
	Ground Bones.		
68	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Boston.
69	Ground Bone,	Armour & Co., Chicago, Ill.,	Hadley.
97	Ground Bone,	National Fertilizer Co., Bridgeport, Conn.,	Spencer.
119	Fine Bone,	Thomas Herson & Co., New Bedford, Mass.,	Taunton.
125	Ground Bone,	National Fertilizer Co., Bridgeport, Conn.,	Hadley.
185	Ground Bone,	Armour & Co., Chicago, Ill.,	Williamstown.
195	Ground Bone,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
205	Pure Raw Bone,	H. J. Baker & Bro., New York, N. Y.,	Amherst.
241	Ground Bone,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Fitchburg.
295	Ground Bone,	T. L. Stetson, Randolph, Mass.,	Amherst.
296	Pure Bone,	John C. Dow & Co., Boston, Mass.,	Amherst.
328	Pure Fine Bone,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Amherst.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.		Mechanical Analysis.			
								Total.		Available.							
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Fine.	Fine Med.	Medium.	Cor'se Med.
	Compound Fertilizers.																
325	Extra Bone Phosphate,	5.37	2.26	2.47-3.30	4.40	4.80	4.50	13.70	10-12	9.20	7-9	3.56	3-5				
326	Potato and Root Crop Manure,	6.85	3.04	3-4	3.50	5.23	5.82	14.55	10-12	8.73	6-8	7.08	7-9				
327	Pure Dissolved Bone,	9.32	2.19	2.06-2.88	10.97	4.57	.88	16.42	16-18	15.54	15-17	—	—				
	Ground Bones.																
68	Pure Ground Bone,	11.10	2.12	2-3	—	8.75	18.77	27.52	27-29	8.75	—			51.38	37.31	11.21	.10
69-185	Ground Bone,	6.87	4.26	2.47-3.30	—	8.30	17.20	25.50	25-28	8.30	10-13			42.53	34.13	17.34	6.00
97-125	Ground Bone,	4.92	1.70	2.88-3.71	—	7.16	21.24	28.40	20-24	7.16	—			69.40	21.10	8.70	.80
119	Fine Bone,	2.20	2.00	2.00	—	6.23	23.29	29.52	30.20	6.23	9.10			81.22	14.30	9.10	.23
195	Ground Bone,	4.26	1.96	1.65-2.47	—	4.70	21.52	26.22	16-20	4.70	13-15			55.49	28.80	15.00	.71
205	Pure Raw Bone,	5.67	4.05	2.47-3.30	—	5.17	18.05	23.22	22.9-27.48	5.17	—			52.19	33.60	13.35	.86
241	Ground Bone,	5.75	1.74	2.9-3.7	—	6.40	23.02	29.42	25-28	6.40	—			42.16	17.32	14.32	26.20
295	Ground Bone,	7.72	4.08	4.-4.5	—	6.91	15.75	22.66	22-23	6.91	—			17.13	23.70	38.97	20.20
296	Pure Bone,	4.00	1.96	1.65-2.47	—	6.31	20.45	26.76	24-26	6.31	—			58.67	41.33	—	—
328	Pure Fine Bone,	6.62	2.60	2.47-3.30	—	6.87	16.52	23.39	22-25	6.87	—			58.13	27.30	14.50	.07

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Chemicals.		
31	Low Grade Sulphate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
33	High Grade Sulphate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
40	Muriate of Potash,	American Fertilizer Co., Boston, Mass.,	Northboro.
48	Sulphate of Ammonia,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
52	Nitrate of Soda,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
53	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
73	Nitrate of Soda,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
74	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
81	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
83	Dissolved Bone Black,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
87	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
96	High Grade Sulphate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Spencer.
104	Low Grade Sulphate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
107	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Spencer.
116	Low Grade Sulphate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Hadley.
122	Double Manure Salts,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
140	Dissolved Bone Black,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
141	Nitrate of Soda,	National Fertilizer Co., Bridgeport, Conn.,	Hadley.
150	Nitrate of Soda,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
169	Nitrate of Soda,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
172	Nitrate of Soda,	E. Frank Coe Co., New York, N. Y.,	Dighton.
202	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Pittsfield.
206	Dissolved Bone Black,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
219	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
222	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
237	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Williamstown.
231	Sulphate of Ammonia,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
258	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
260	Dissolved Bone Black,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Chemicals.												
31-104	Low Grade Sulphate of Potash,	1.75	—	—	—	—	—	—	—	—	—	26.28	24-26
33	High Grade Sulphate of Potash,	.37	—	—	—	—	—	—	—	—	—	49.96	50-52
40	Muriate of Potash,	1.30	—	—	—	—	—	—	—	—	—	50.84	50-52
48-231	Sulphate of Ammonia,	1.25	20.13	19.78-20.60	—	—	—	—	—	—	—	—	—
52	Nitrate of Soda,	1.67	15.34	—	—	—	—	—	—	—	—	—	—
53-219-228-258	Muriate of Potash,	1.30	—	—	—	—	—	—	—	—	—	50.85	50-52
73	Nitrate of Soda,	1.58	15.40	14.5-16.5	—	—	—	—	—	—	—	—	—
74-222	Nitrate of Soda,	2.52	15.37	15.25-16.06	—	—	—	—	—	—	—	—	—
81	Muriate of Potash,	1.17	—	—	—	—	—	—	—	—	—	51.14	50.54-53.70
83-205-260	Dissolved Bone Black,	16.35	—	—	13.57	2.12	.31	16.00	16-18	15.69	15-18	—	—
87-107-202	Muriate of Potash,	1.70	—	—	—	—	—	—	—	—	—	47.25	48-55
96	High Grade Sulphate of Potash,	.37	—	—	—	—	—	—	—	—	—	49.96	50-52
116	Low Grade Sulphate of Potash,	1.75	—	—	—	—	—	—	—	—	—	26.28	25.94-29.72
122	Double Manure Salts,	1.75	—	—	—	—	—	—	—	—	—	26.28	25.94-28.10
140	Dissolved Bone Black,	10.72	—	—	5.75	9.75	1.27	16.77	—	15.50	15-18	—	—
141-150	Nitrate of Soda,	2.46	15.33	15.64	—	—	—	—	—	—	—	—	—
169	Nitrate of Soda,	2.53	14.91	—	—	—	—	—	—	—	—	—	—
172	Nitrate of Soda,	2.53	15.46	—	—	—	—	—	—	—	—	—	—

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1896 IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Chemicals.		
207	Muriate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
210	Muriate of Potash,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
216	Superphosphate,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
229	Hige Grade Sulphate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
230	Dried Blood,	Bowker Fertilizer Co., Boston, Mass.,	Amherst.
233	Double Manure Salts,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
236	Sulphate of Ammonia,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
239	Muriate of Potash,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
240	Dissolved Bone Black,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
243	High Grade Sulphate of Potash,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
245	Nitrate of Soda,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
248	High Grade Sulphate of Potash	Quinnipiac Co., Boston, Mass.,	Springfield.
251	Muriate of Potash,	Quinnipiac Co., Boston, Mass.,	Springfield.
255	Nitrate of Soda,	Quinnipiac Co., Boston, Mass.,	Springfield.
256	High Grade Sulphate of Potash,	Bowker Fertilizer Co., Boston. Mass.,	Springfield.
253	Acid Phosphate,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
262	Fresh Milled Kainit,	Bowker Fertilizer Co., Boston, Mass.,	Springfield.
285	Low Grade Sulphate of Potash,	H. J. Baker & Bro., New York, N. Y.,	Amherst.
320	Electrical Dissolved Bone,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
324	High Grade Sulphate of Potash,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Amherst.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	Guaranteed.
								Found.	Guaranteed.	Found.	Guaranteed.		
	Chemicals.												
207	Muriate of Potash,	1.30	—	—	—	—	—	—	—	—	—	50.84	50.54-53.70
210	Muriate of Potash,	1.34	—	—	—	—	—	—	—	—	—	50.80	50.54 53.60
216	Superphosphate,	13.12	—	—	10.37	4.01	1.06	15.44	13-15	14.38	11-13	—	—
229 256	High Grade Sulphate of Potash,	.37	—	—	—	—	—	—	—	—	—	49.96	48-52
230	Dried Blood,	6.73	9.60	9.89-11.53	—	—	—	—	—	—	—	—	—
233	Double Manure Salts,	1.75	—	—	—	—	—	—	—	—	—	26.28	25.94-28.10
236	Sulphate of Ammonia,	1.12	20.19	19.76-20.58	—	—	—	—	—	—	—	—	—
239-251	Muriate of Potash,	1.30	—	—	—	—	—	—	—	—	—	50.8	50.54-53.70
240	Dissolved Bone Black,	10.47	—	—	9.44	5.81	1.67	16.92	—	15.25	15-18	—	—
243-248	High Grade Sulphate of Potash,	.37	—	—	—	—	—	—	—	—	—	49.96	48.63-51.34
245-255	Nitrate of Soda,	2 52	14.72	15.48-15.81	—	—	—	—	—	—	—	—	—
253	Acid Phosphate,	11.65	—	—	7.47	5.83	1.47	14.77	—	13.30	12-15	—	—
262	Fresh Milled Kainit,	3.30	—	—	—	—	—	—	—	—	—	14.96	11-13
285	Low Grade Sulphate of Potash,	1.75	—	—	—	—	—	—	—	—	—	26.28	—
320	Electrical Dissolved Bone,	11.15	—	—	4.80	7.15	2.60	14.55	15-20	11.95	13-17	—	—
324	High Grade Sulphate of Potash,	.37	—	—	—	—	—	—	—	—	—	49.96	50.79-51.87

LAWS FOR THE REGULATIONS OF THE TRADE IN COMMERCIAL FERTILIZERS IN MASSACHUSETTS.

LAWS PASSED IN 1888.

SECT. 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, *the retail price of which is ten dollars or more per ton*, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen *or its equivalent in ammonia*, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

SECT. 2. Before any commercial fertilizer, *the retail price of which is ten dollars or more per ton*, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall file with the director of the Hatch Experiment Station of the Massachusetts Agricultural College, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SECT. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, *the retail price of which is ten dollars or more per ton*, shall pay for each brand, on or before the first day of May annually, to the director of the Hatch Experiment Station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed

[SEE PAGE 26.]

CHANGES IN THE LAWS FOR THE REGULATION OF THE TRADE IN COMMERCIAL FERTILIZERS IN MASSACHUSETTS.

The recent changes in our laws are rendered prominent by being, in both, printed in Italics.

LAWS PASSED IN 1896.

SECTION 1. *Every lot or parcel of commercial fertilizer or fertilizer material sold or offered or exposed for sale within this Commonwealth shall be accompanied by a plainly printed statement*, clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade-mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the location of the factory, and a chemical analysis *stating the percentage of nitrogen*, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

SECT. 2. *Before any commercial fertilizer is sold or offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within this Commonwealth* shall file with the director of the Hatch Experiment Station of the Massachusetts Agricultural College a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request, a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SECT. 3. *The manufacturer, importer, agent or seller of any brand of commercial fertilizer or fertilizer material shall pay for each brand*, on or before the first day of May annually to the director of the Experiment Station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand of fertilizer *provided*, that whenever the manufacturer or importer

[SEE PAGE 27.]

to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on recipt of said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, *any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure*, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offense.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

SECT. 7. The director of the Hatch Experiment Station shall pay the analysis fees, as soon as received by him, into the treasury *of the Massachusetts Agricultural College*, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, *and publish the results monthly, with such additional information as circumstances advise: provided*, such information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not

[SEE PAGE 28.]

shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell or offer or expose for sale in this Commonwealth *any pulverized leather, hair or wool waste, raw, steamed, roasted or in any form as a fertilizer, or as an ingredient of any fertilizer or manure*, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling or offering or exposing for sale any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use and not to sell in this commonwealth.

SECT. 7. The director of the experiment station shall pay the analysis fees, as soon as received by him, *into the treasury of the station*, and shall cause one analysis or more of each fertilizer or fertilizer material to be made annually, *and shall publish the results from time to time*, with such additional information as the circumstances render advisable, provided such information relates only to the composition of the fertilizer or fertilizer material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or fertilizer material which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest, or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent of the

[SEE PAGE 29.]

less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample ; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station ; *but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.*

SECT. 8. *Sections eleven to sixteen inclusive of chapter sixty of the Public statutes are hereby repealed.*

SECT. 9. *This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [Approved May 3, 1888.]*

whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels, and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn, and the time and place of drawing; and said label shall also be signed by the director or his deputy and by the party or parties in interest, or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station.

SECT. 8. *Chapter two hundred and ninety-six of the acts of the year eighteen hundred and eighty-eight is hereby repealed.*

SECT. 9. *This act shall take effect on the first day of November in the year eighteen hundred and ninety-six.* [*Approved April 17, 1896.*]

Instructions to Manufacturers, Importers, Agents, and Sellers of Commercial Fertilizers or Materials used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied:

First, with a distinct statement of the name of each brand offered for sale.

Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

Third, With the fee charged by the State for a certificate, which is five dollars for each of the following articles: nitrogen, phosphoric acid and potassium oxide guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to Compound Fertilizers but to all substances, single or compound, used for manurial purposes and offered for sale.

3. The certificate must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many Agents as they desire after having secured at this office the certificate of compliance with our State laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

All inquiries regarding the sales of commercial fertilizers, etc., may be addressed to C. A. Goessmann, Chemist in charge of the official inspection of these articles, Amherst, Mass.

Amherst, Mass., Oct., 1896.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1896. *Cents per pound.*
Nitrogen in ammonia salts,	15.
“ “ nitrates,	13.5
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	14.
“ “ “ cotton-seed meal,	12.
“ “ “ fine ground bone and tankage,	13.5
“ “ “ fine ground medium bone and tankage,	12.
“ “ “ medium bone and tankage,	9.
“ “ “ coarse bone and tankage,	3.
“ “ “ hair, horn-shavings and coarse fish scraps,	3.
Phosphoric acid soluble in water,	5.5
“ “ soluble in ammonium citrate,	5.
“ “ in fine bone and tankage,	5.
“ “ in fine medium bone and tankage,	4.
“ “ in medium bone and tankage,	2.5
“ “ in coarse bone and tankage,	2.
“ “ in fine ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	4.5
“ “ insoluble (in am. cit.) in mixed fertilizers,	2.
Potash as High Grade Sulphate, and in mixtures free from Muriate,	5.
“ “ Muriate,	4.5
The manurial constituents contained in feedstuffs are valued as follows:	
Organic Nitrogen,	12.
Phosphoric acid,	4.5
Potash,	5.

The above trade values are the figures at which, in the six months preceding March, 1896, the respective ingredients could be bought at *retail for cash in our large markets*, *in the raw materials*, which are the regular source of supply.

Amherst, Mass., October, 1896.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 43.

ELECTRO-GERMINATION.

PHYSIOLOGICAL LABORATORY.

JANUARY, 1897.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1897.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Benjamin K. Jones, B. Sc.,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

Division of Botany.

Asa S. Kinney.

For the past century and a half, scientists have been at work upon the relation of electricity to plant life.* Since the experiments of Mainbray in 1746, who was the first to study the influence of electricity upon the growth of plants, such men as Jolabert, Nollet, Ingenhouse, Sylvestre, Sir Humphry Davy, Humboldt, Wollaston, Becquerel, Sheppard, Hubeck and many others have been prominent.

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*The following experiments by Mr. Asa S. Kinney, a graduate of the Massachusetts Agricultural College in the class of 1896, upon electro-germination were made for the purpose of gaining some definite knowledge of the influence of electricity upon plants. There are many doubts among physiologists as to the claims made for electricity upon plant growth, the cause of which is due to the fact, that the experimental data are surprisingly noted for the lack of definite information which they convey. Most of the deductions made, have been based upon merely superficial observation. I know of no experiments along this line, in which numerous measurements and comparisons of a large number of treated and normal plants, placed under exactly similar conditions have been made. Notwithstanding this, every now and then, we read about the modern farmer equipped with a dynamo, forcing strong currents through the soil, claiming *as a result*, that he can raise four or five crops to the ordinary farmer's one. Such statements have little value other than a sensational one, although it must be said that there are facts underlying these statements which possess a reliable basis. All experimenters however, have not been able to obtain positive results by the use of electricity. It can readily be seen from the results of Mr. Kinney's experiments that many of the negative results, which have often been reported, can be accounted for by the fact that the strength of current which accelerates germination and growth is quite limited and consequently a current which did not come within this limit would have no effect.

These experiments, as well as many subsequent ones, show conclusively that electricity, when properly applied, accelerates germination and growth, and furthermore that our experiments have progressed far enough to show that, in many respects, electricity acts quite similar to light in its stimulating effect. There remain however many important questions to be settled before we know definitely the proper methods of electrically treating plants in the soil, such for example as the best methods of applying the stimulation, what strength of current is best to secure the maximum growth and whether it can be profitably applied in greenhouses. The results in the following paper are based upon the measurements of about 3000 roots and nearly 1000 stems, and in all of the experiments, except in tables XII–XIX two hundred seeds have been planted under exactly similar conditions. By this method the variations which are too often disregarded, such as variations due to external influences and the ever present individual variations have been eliminated so far as possible.

G. E. Stone.

The experiments of Abbé Nollet are worthy of special notice, he being the first to apply electricity as a stimulus to germination with favorable results. Later N. Specnew submitted different seeds to the action of an electric current and found that germination was much accelerated. He took two lots of twelve groups containing one hundred and twelve seeds each, soaked them in water until thoroughly moistened, and while wet, placed them in glass cylinders open at either end. Copper discs which were connected with the poles of an induction coil, were pressed against the seeds and a current passed through them for one or two minutes. After this, the seeds were sown, the temperature being kept at 45° to 50° Fahrenheit. The following are Specnew's results:

	Beans. Days.	Peas. Days.	Barley. Days.	Sunflowers. Days.
Seeds submitted to the action of electricity developed in	2.5	3	2	8.5
Normal seeds developed in	4	6	5	15

An experiment, similar in certain respects, was conducted by Paulin, who discovered that the electric current would awaken life in seeds which had apparently lost all vitality. Seed which would not germinate in the usual way, sprouted readily after being treated with an electric current. In fact, all seeds which he treated were found to germinate much more rapidly and give better plants than those which had not been subjected to electric influence. Paulin's apparatus was quite simple, consisting of a frictional machine and a wide neck glass bottle. Within the bottle were placed moistened seeds and around it was pasted tinfoil forming a Leyden Jar, the seed acting as the inner coating. The bottle was then closed with a perforated stopper and a wire inserted among the seed. By means of this wire, the jar was connected with the conductors of the frictional machine and the seeds charged. With the seeds of garden vegetables this process of charging was continued hourly for twelve hours; with grain hourly for twenty-four hours, while with fruit and forest trees the treatment was continued twelve hours daily for a period of eight days. Paulin also noticed that the seeds must be planted while still moist, or the electrical effect would be destroyed.

Tschinkel showed that certain seeds germinated from six to eight days earlier in soil through which an electric current had been circulated, while similar experiments, carried on by Professor Wollny of Munich, with summer rye, radishes, rape-seed and potatoes gave negative results.

The experiments conducted in the Botanical Laboratory of the Massachusetts Agricultural College have followed in many instances those of Specnew, previously described. The objects of these experiments have been three fold. First, to determine whether the seed germ responded in any way when subjected to electrical influence. Second, should there be any visible action, to determine whether it was injurious or beneficial. Third, to determine the effect of different strengths of current. These experiments have been carried on from a scientific standpoint rather than from any practical application to which they may be put, although with proper apparatus the use of electricity may prove of considerable service in the germination of some small seeds which under ordinary conditions start very slowly.*

APPARATUS AND METHODS.

The kinds of apparatus and the methods described are those which gave the best results, while others, employed at first, but found unsatisfactory have not been considered.

The batteries used in the experiments were of two kinds, namely, four Leclanché cells arranged in series giving an electro-motive force of from four to five volts and two No. 1 Samson cells giving an electro-motive force of two and eighty-eight hundredth volts. Had long periods of treatment been desired, gravity cells would have answered the purpose much better, but as the current was never used for more than five minutes at a time and then the battery allowed a period of rest, no difficulty was experienced from its running down and a comparatively constant strength of current could be obtained. The great advantage gained in using the Sal ammoniac battery is the ease with which it may be set up and renewed when exhausted.

In order that a large variation in electro-motive force could be obtained, an induction coil was employed. The one in use was a Du Bois-Reymond inductorium, manufactured by the Cambridge Scientific Instrument Co., England. This coil is a form of the Ruhmkorff apparatus, but has several special modifications which makes it especially adapted to this form of experiment. In figure 1 there is shown at (I) a side view of the coil as it is set up for use. The primary coil (C), consisting of a core of soft iron rods, is fixed and wound with about one hundred and thirty turns of moderately thick insulated copper wire. The secondary coil (B), having six thousand turns of fine copper wire, is quite separate from the primary coil and slides in a groove in the wooden standard. In this way the secondary coil may be brought over the primary coil or removed quite a distance from it.

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*Those who are not interested in the minute details connected with these experiments can obtain an idea of the results by glancing at the figures in the accompanying tables and at the general summary of results at the end.

As the coil (B) is removed from the coil (C) the amount of induced current in (B) is decreased and when moved toward (C) the current is increased. A centimetre scale about one metre in length is placed beside the groove through which the coil (B) is moved, so that the distance between the two coils (B) and (C) can be easily measured. At one end of the primary coil is the so called Wagner hammer (T) which "makes" and "breaks" the primary current about fifty times per second. The two poles of the battery are connected with the Wagner hammer by two binding screws which in turn connect with the primary coil (C). At each "make" and "break" caused by the Wagner interrupter, an induced current is set up in the coil (B), from which it may be conducted off by connecting wires to the binding posts at the end of coil (B). At (D) Figure 1 is shown a key by means of which a short circuit may be formed.

In some of the experiments, hourly treatment was desired. This was accomplished by passing the wires from the battery to an electric clock and thence to the induction machine. Each hour, the clock formed a connection completing the circuit and a current was passed through for a period of about thirty seconds.

METHODS OF APPLYING THE STIMULATION.

In experiments given in tables I—XVII, the apparatus represented in Figure 2 was used. This consisted of two glass cylinders, a larger one about two inches in diameter for large seeds and a smaller about three fourths of an inch in diameter for those of less size. Within these cylinders, thoroughly moistened seeds were placed and the openings closed with copper discs having wires attached. By means of these wires the discs were connected with the poles of the induction coil and a current passed through, the moist seeds making a good conductor. After the seeds had been stimulated by passing the current through them they were placed in germinating pans as shown in figure 5.

Another method of applying the stimulation is shown in Figure 3. This consists of two seven-inch glass funnels. Within each of these funnels are two copper discs, a small one at the bottom and a larger one at the top. In the upper disc of each funnel are twelve holes, at equal intervals around the edge, to allow the hypocotyls to grow through. Between the discs of each funnel is placed a layer of moist sand in which the seeds are planted. To the discs of one funnel are attached wires, by means of which they are connected with the poles of the induction coil. In this way a current may be passed through the moistened sand which acts as a good conductor.

The object of taking a funnel, rather than a cylinder, is that the action of gravity constantly draws the roots against the glass, allowing measurements to be taken from the outside, whereas were the sides vertical, nutation and such forces as hydrotropism might cause the root to grow inward and away from the glass.

In experiments with this apparatus the seeds were first germinated in sawdust and when the radicles had reached a length of about two centimeters they were removed to the funnels where the subsequent growths of the normal and stimulated plants were compared.

In Figure 4 is shown an apparatus very similar to that in Figure 3 with the exception that in this case four-inch clay pots were substituted for the funnels.

This apparatus is not adapted for observation of root growth, but simply that of the hypocotyls. In the upper discs are seven holes through which the young seedlings grow, as shown in the diagram in Figure 4, which represents a cross section of the pot where the plants were treated with electricity.

GERMINATING APPARATUS.

In the selection of germinating pans for this work two chief points have been taken into consideration. First, that the normal or untreated seeds should have exactly the same environments as those treated, aside from the conditions brought about by the application of electricity. Second, that the conditions for germination should be as favorable as possible, that is, that there should be the proper amount of heat, air and moisture to give the best possible conditions.

The form of apparatus which was used in these experiments and which seems to fulfil the requirements very well is shown in Figure 5. This consists of two plates, an outer of porcelain about nine inches in diameter, and an inner of clay seven inches in diameter. Within the inner plate filter-paper is placed upon which the seeds are sown. In the outer plate a constant supply of water is kept which gradually passes through the plate of porous clay, keeping the filter-paper within, constantly moist. The seeds are sown upon the filter-paper in the manner shown in the left hand pan in Figure 5. The paper is divided into eight equal parts, seven of these are used for the treated seeds while the eighth or 0 is for the normal or untreated seeds.

A second piece of moist filter-paper is placed over the seeds, resting upon them and touching at various points the paper beneath. In this manner the covering is kept moist by absorption. A plate prepared for germination is shown at the right in Figure 5. In order to insure perfect darkness a piece of black cardboard was placed over the pan in such a manner as to shut out the light, but not prevent a free circulation of air.

In this form of pan the young plants can be grown without difficulty until the hypocotyls are two or three centimeters long. The moist filter-paper, which constitutes the covering of the seeds, offering but little obstruction to growth.

EFFECTS OF ELECTRICITY IN GERMINATION AND GROWTH OF RADICLES, (ROOTS).

Of White Mustard (Brassica alba, Boiss) Red Clover (Trifolium pratense, L) Rape (Brassica napus, L.) and Barley (Hordeum vulgare, L.)

TABLES I.—VIII.

In Tables I.—IV. the seeds were treated with an interrupted induced current from a Du Bois-Reymond induction coil for a period of two minutes, the coil being connected with a four Leclanché cell battery. Two hundred seeds of each variety were taken. These were soaked in water for a period of twenty-four hours, after which each lot of two hundred seeds was divided into eight lots of twenty-five seeds each. Seven of these lots were treated with the electric current in the apparatus shown in Figure 2, as previously described. The eighth was left untreated and served as normal plants for comparison. After treatment, these seeds were sown in germinating pans as shown in Figure 5, which, after having been prepared for germination, were placed where the temperature was kept from 18° C (64.4° F) to 20° C (68° F).

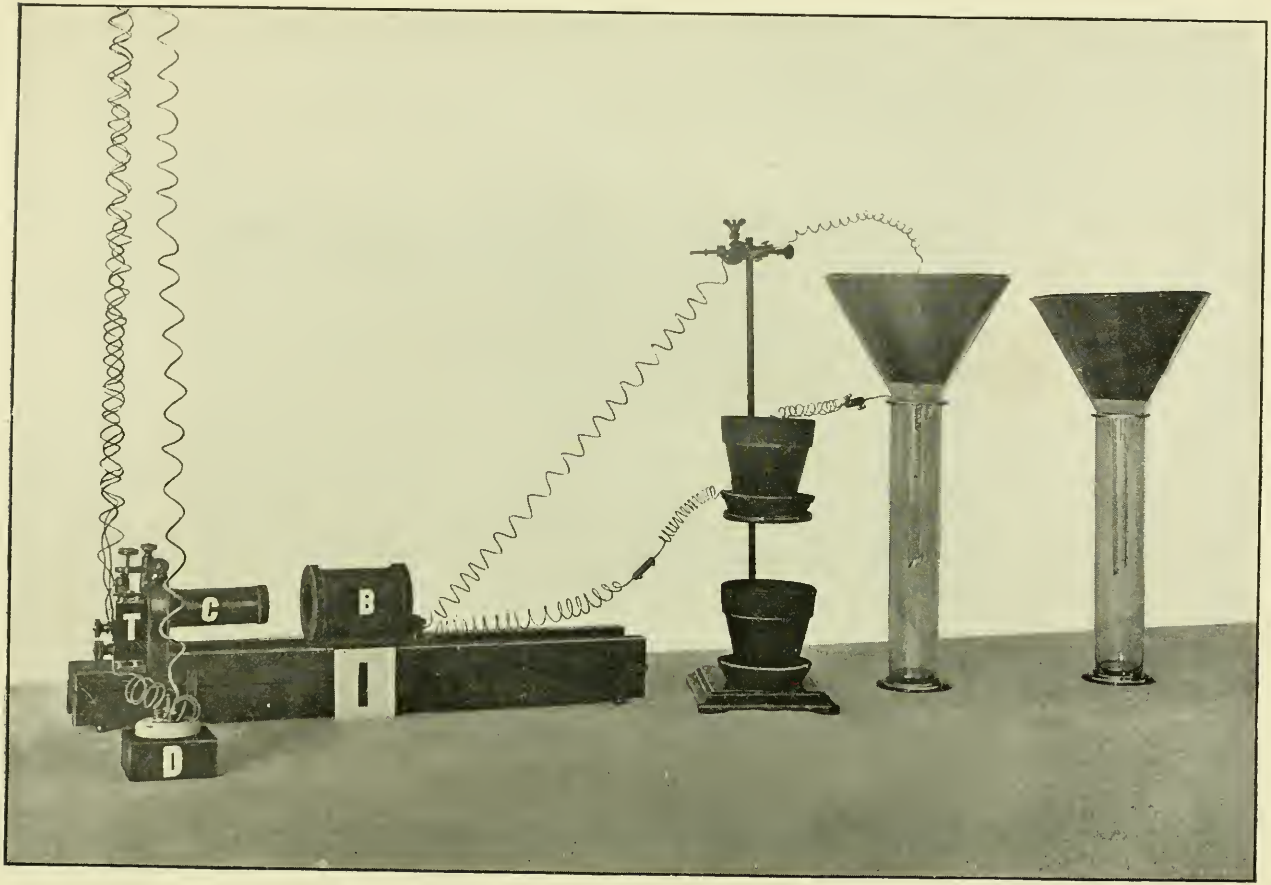

FIG. 1.

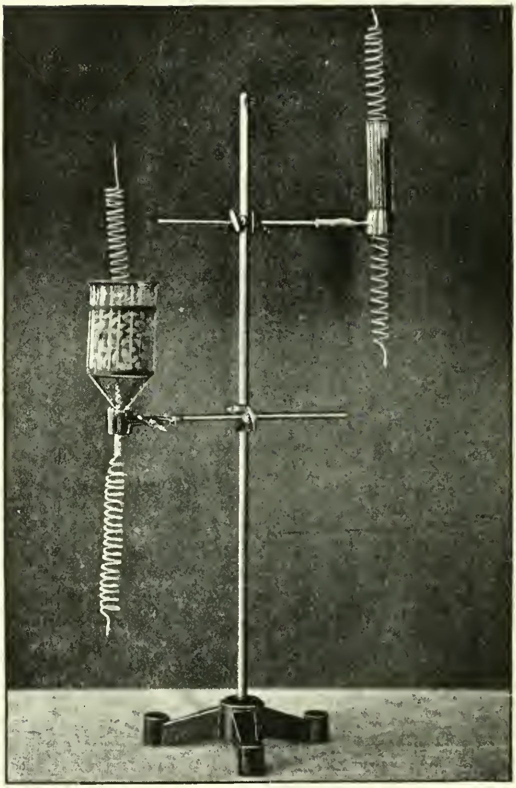

FIG. 2.

In the tables, the first column at the left indicates the strength of current to which each lot of seeds was subjected. At the top in each table are given the normal or untreated plants while the following numbers 1, 3, 5 etc. show the distance in centimeters to which the secondary coil was removed from the primary coil upon the graduated base, or in other words they represent the strength of current, the strongest at 1 being about 10-12 volts, the weakest at 17 a small fraction of a volt. In the following three columns is given the number of seeds germinated in 24, 48 and 72 hours respectively. In the fifth column the numbers show an average of the lengths in centimeters* of all the radicles in each lot of twenty-five seeds at the close of the experiment. The last column contains the gain per cent by use of electricity. Following some of the tables will be seen a diagramatic representation of the results given in the column of the average lengths of radicles. Each figure in the diagram represents an average growth in the length of all the radicles in each lot of seeds.

Tables V.—VIII. are a repetition of the experiments in the first four tables, the only variation being that in the place of the four Leclanché cell battery a two Samson No. 1 cell battery was substituted and instead of treating the seed for only two minutes the treatment was continued for five minutes.

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*The centimeter approximates three-eighths of an inch.

TABLE I.

Effect of the electric current upon the germination and growth of radicles of

WHITE MUSTARD (BRASSICA ALBA).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Average l'gth (in centimeters) of radicles at close of experiment.	Per cent gain in radicles by use of electricity.
Normal plants (no current).	12	16	21	2.35	0
1	14	22	22	3.01	28.09
3	13	23	23	3.12	32.76
5	15	20	20	3.20	36.17
7	16	24	24	**3.31**	**40.85**
11	13	21	21	3.17	34.89
15	12	19	19	3.10	31.91
17	12	19	19	3.00	27.66

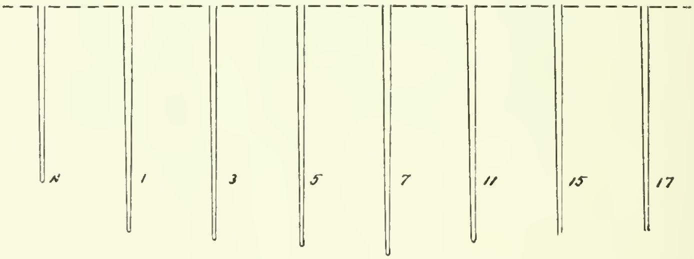

FIG. 6.

Diagramatic representation of the results in Table I. showing the growth of radicles.

TABLE II.

Effect of the electric current upon the germination and growth of radicles of

RED CLOVER (TRIFOLIUM PRATENSE).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Average l'gth (in centimeters) of radicles at close of experiment.	Per cent gain in radicles by use of electricity.
Normalplants (no current).	10	21	23	1.40	0
1	11	22	22	1.56	11.43
3	13	22	22	1.45	3.57
5	15	21	21	1.54	10.00
7	13	23	23	1.57	12.14
11	13	22	22	1.59	13.57
15	14	23	23	1.52	8.57
17	11	22	22	1.43	2.22

TABLE III.

Effect of the electric current upon the germination and growth of radicles of

RAPE (BRASSICA NAPUS).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Average l'gth (in centimeters) of radicles at close of experiment.	Per cent gain in radicles by use of electric current.
Normal plants (no current).	0	12	15	2.10	0
1	2	14	15	2.77	31.90
3	3	17	17	2.80	33.33
5	2	16	18	3.30	57.14
7	4	17	18	3.40	61.90
11	4	16	16	**3.75**	**78.59**
15	3	16	16	3.21	52.38
17	3	13	15	3.00	42.85

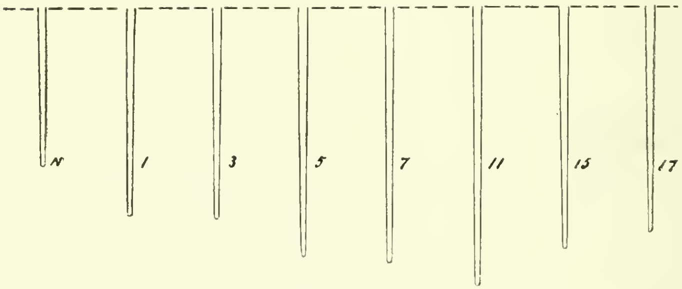

FIG. 7.

Diagramatic representation of the results in Table III. showing the growth of radicles.

TABLE IV.

Effect of the electric current upon the germination and growth of radicles of

BARLEY (HORDEUM VULGARE).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Average l'gth (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.
Normalplants (no current).	5	12	19	3.10	0
1	7	14	21	3.85	24.19
3	9	15	20	3.91	26.13
5	11	13	21	3.80	22.58
7	8	15	22	**4.12**	**32.90**
11	9	17	19	4.02	29.67
15	7	13	17	3.75	20.97
17	7	13	18	3.45	11.29

TABLE V.

Effect of the electric current upon the germination and growth of radicles of

WHITE MUSTARD (BRASSICA ALBA).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Average l'gth (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.
Normal plants (no current).	11	18	20	2.35	0
1	13	22	22	3.52	49.74
3	15	22	22	3.30	40.42
5	14	24	24	3.24	37.87
7	16	24	24	3.22	37.02
11	13	23	23	3.20	36.17
15	14	22	22	3.03	28.93
17	12	19	19	2.63	11.91

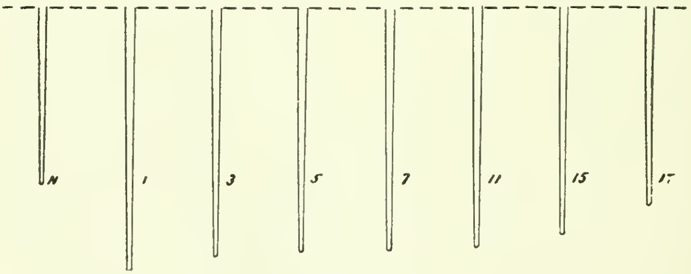

FIG. 8.

Diagramatic representation of the results in Table V. showing the growth of radicles.

TABLE VI.

Effect of the electric current upon the germination and growth of radicles of

RED CLOVER (TRIFOLIUM PRATENSE.)

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Average l'gth (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.
Normalplants (no current).	13	19	20	1.45	0
1	13	20	22	1.80	24.14
3	13	18	20	1·65	13.79
5	12	20	20	1.52	4.83
7	13	21	23	1.60	10.34
11	16	24	24	1.55	6.89
15	15	21	22	1.50	3.45
17	15	23	23	1.48	2.07

TABLE VII.

Effect of the electric current upon the germination and growth of radicles of

RAPE (BRASSICA NAPUS).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Average l'gth (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.
Normal plants (no current).	5	12	14	2.70	0
1	9	16	16	**3.62**	**34.07**
3	9	10	10	3.44	27.41
5	10	12	12	3.40	25.92
7	9	13	13	3.39	25.55
11	8	11	11	3.24	20.00
15	7	14	14	3.10	14.81
17	8	10	12	2.90	.74

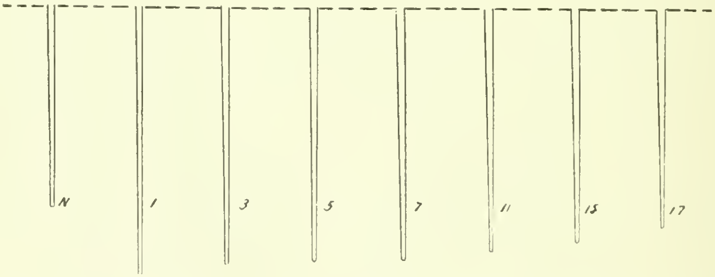

FIG. 9.

Diagramatic representation of the results in Table VII. showing the growth of radicles.

TABLE VIII.

Effect of the electric current upon the germination and growth of radicles of

BARLEY (HORDEUM VULGARE).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Average l'gth (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.
Normalplants (no current).	4	9	12	3.20	0
1	5	16	18	4.20	31.25
3	4	12	15	3.80	18.75
5	6	17	18	4.05	26.56
7	5	14	15	4.01	25.31
11	7	15	16	4.04	26.25
15	6	17	17	3.98	24.37
17	5	16	19	3.60	12.50

In the foregoing eight tables sixty-four lots of twenty-five seeds each were used, or in all sixteen hundred seeds. Of these, fifty-six lots received treatment, while eight were kept as normal plants or checks for the treated seeds. In drawing conclusions from the results obtained, it has been thought best to take a general average of the various results in all the tables rather than to compare the results of individual tables, for in the former method the danger of error from individual variation is much lessened as there are a greater number of seeds compared.

In order to determine whether germination was hastened by treatment, an average was made of the total number of seeds germinating in 24, 48 and 72 hours respectively. The following table shows the result obtained by such an average:

		Treated.	Untreated.	Gain Per cent, by treatment.
Average number seeds germinated in each lot in	24 hours	9.93	7.50	32.40
	48 hours	18.00	14.87	21.05
	72 hours	19.14	18.00	6.33

From these results it will be noticed that by applying electricity, germination was considerably hastened and that those lots of seeds which received treatment, gave a higher percentage of germination at the close of the experiments. This latter condition may be due to the fact that the treated seeds germinated more quickly than the normal, and that there still remained in the normal, seeds which would have germinated had the experiment been conducted for a longer period of time. An examination of the following tables seems to prove however that this was not the case, but that the electric current awakened life in some seeds which without treatment would have remained dormant.

It will also be noticed in the tables that there was quite a variation in the lengths of radicles with the various strengths of current. As the secondary coil was removed from the primary, consequently weakening the current, there was a gradual increase in the length of radicles until an optimum* effect was reached. From this point there was a decrease and had there been used a sufficiently weak current there would have been found without doubt a point at which no effect could be seen.

In the first four tables this optimum stimulation was at seven centimeters (in one case eleven) while in the second four, it was at one centimeter. The cause of this variation in the second series of tables is due to the fact that the battery used in this case had a lower voltage than the one used in the first, the optimum current being in each case about 3 volts.

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*The optimum current or stimulation is that which gives the best results.

An average of the lengths of the radicles in all the lots of seed which were treated with the optimum strength of current gives 3.24 centimeters while an average of the normals gives 2.33 centimeters or an increase of 39.06 per cent by treating the seeds with the electric current.

Some of the tables seem to show that there is an optimum strength of current for germination as well as for growth of radicles. This optimum for germination in the first four tables is very nearly the same as that for the radicles, but there is so much variation in the other tables that no conclusion can be drawn upon this point.

EFFECTS OF ELECTRICITY ON GERMINATION AND GROWTH OF RADICLES (ROOTS) AND HYPOCOTYLS ** (STEMS)

Of White Mustard (Brassica alba, Boiss) Rape (Brassica napus, L.) and Red Clover (Trifolium pratense, L.)

TABLES IX.—XI.

The experiments in these tables are similar to those given in tables I.—IV. with the exception that measurements were also taken of the hypocotyls, in which case it was more convenient on account of the greater maturity of the hypocotyls, to make the measurements at the end of 96 hours instead of at 72 hours as in the previous tables. In the following three tables the average lengths in centimeters of the hypocotyls are given, having been determined in the same manner as were the lengths of the radicles.

**The term Hypocotyl is used by botanists to indicate that portion of the stem below the cotyledons or seed leaves, see Figs. 10-11 and 12.

TABLE IX.

Effect of the electric current upon the germination and growth of radicles and hypocotyls of

WHITE MUSTARD (BRASSICA ALBA).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Number seeds germinated in 96 hours.	Av'ge length (in centimeters) of radicles at close experiment.	Per cent gain in radicles by use of electricity.	Av'ge length (cent'm'ers) of hypocotyls at close of exper'm't	Per cent gain in hypocotyls by use of electricity.
Normal plants (no current.)	16	19	21	21	6.11	0	3.22	0
1	18	20	20	20	6.85	12.11	3.35	4.04
3	17	19	21	21	**7.10**	**16.20**	**3.56**	**10.56**
5	19	21	21	21	6.98	14.23	3.50	8.69
7	18	20	20	20	6.92	13.26	3.50	8.69
11	18	20	22	22	6.75	10.47	3.30	2.49
15	17	19	19	19	6.30	3.10	3.25	.93
17	17	18	18	18	6.20	1.49	3.25	.93

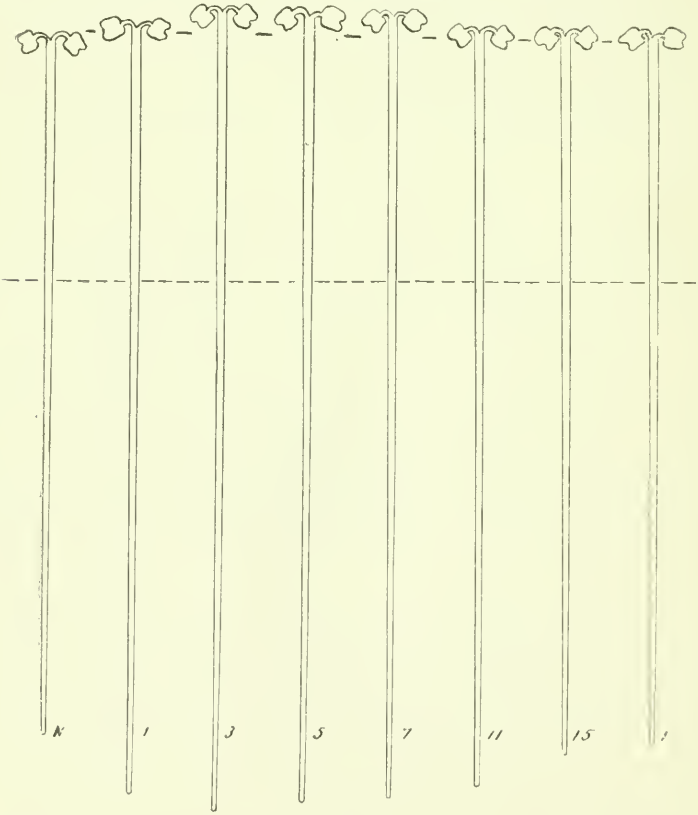


FIG. 10.

Diagramatic representation of the results in Table IX. showing the average length of radicles and hypocotyls.

TABLE X.

Effect of the electric current upon the germination and growth of radicles and hypocotyls of

RAPE (BRASSICA NAPUS).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Number seeds germinated in 96 hours.	Av'ge length (in centimeters) of radicles at close experiment.	Per cent gain in radicles by use of electricity.	Av'ge length (cent'm'ers) of hypocotyls at close of exper'm't	Per cent gain in hypocotyls by use of electricity.
Normal plants (no current).	6	9	11	11	4.12	0	3.56	0
1	9	12	14	14	4.48	8.74	3.65	2.53
3	8	12	15	15	4.53	9.95	3.78	6.18
5	8	10	13	13	**4.58**	**11.16**	**3.80**	**6.74**
7	9	12	14	14	4.41	7.04	3.72	4.49
11	7	13	17	17	4.35	5.58	3.66	2.80
15	8	12	15	15	4.16	.99	3.60	1.12
17	6	10	12	12	4.16	.99	3.56	0

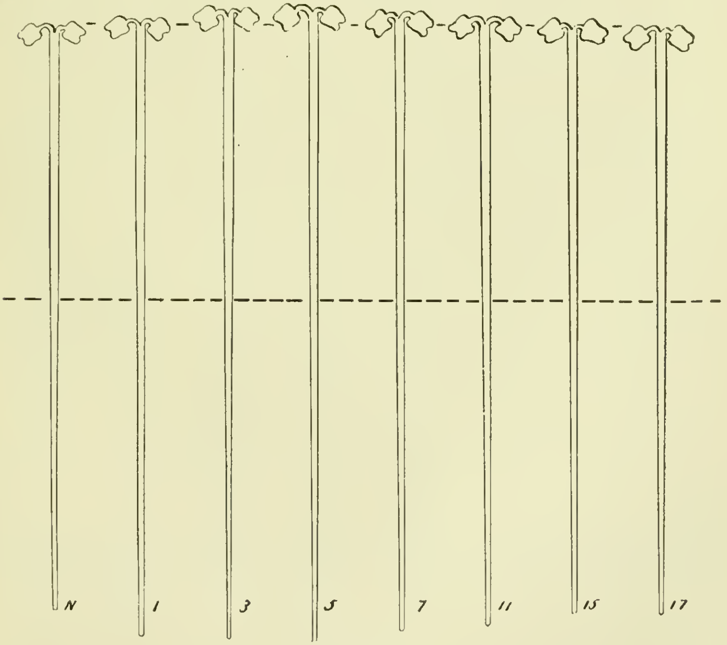


FIG. 11.

Diagramatic representation of the results in Table X. showing the average lengths of radicles and hypocotyls.

TABLE XI.

Effect of the electric current upon the germination and growth of radicles and hypocotyls of

RED CLOVER (TRIFOLIUM PRATENSE).

Strength of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Number seeds germinated in 96 hours.	Av'ge length (in centimeters) of radicles at close experiment.	Per cent gain in radicles by use of electricity.	Av'ge length (cent'm'ers) of hypocotyls at close of exper'm't	Per cent gain in hypocotyls by use of electricity.
Normal plants (no current).	12	18	22	22	2.00	0	2.56	0
1	14	23	23	23	2.10	5.00	2.67	4.29
3	16	20	20	20	2.12	6 00	3.04	18.75
5	15	21	21	21	**2.32**	**16.00**	**3.10**	**21.09**
7	14	20	20	20	2.27	13.50	2 98	16.40
11	14	19	19	19	2.20	10.00	3.02	17.97
15	13	19	20	20	2.12	6.00	3.00	17.18
17	15	21	23	23	2.05	2.50	2.61	1.91

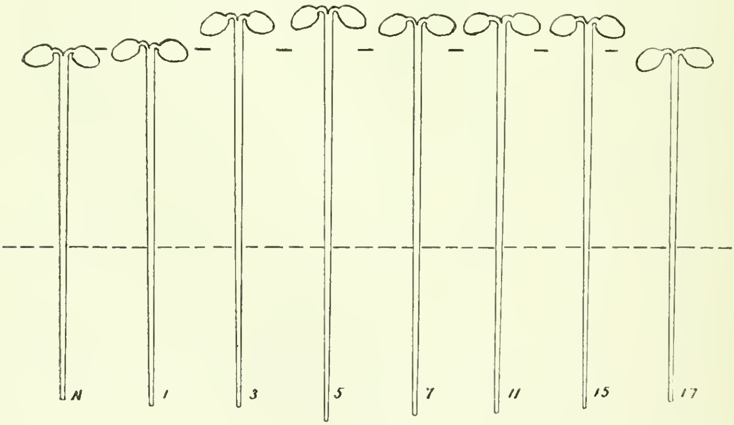


FIG. XII.

Diagramatic representation of the results in Table XI. showing the average lengths of radicles and hypocotyls.

In tables IX.—XI. will be seen a duplicate of the first series, so far as treatment and varieties of seeds used are concerned, but in this series the plants were allowed to grow for ninety-six hours, after which measurements were taken of both radicles and hypocotyls. Essentially these results correspond very closely with those in tables given in the first series, but in special cases variations may be seen. It will be noticed, although the same four Leclanché cell battery was used as in tables I.—IV., that the optimum strength of current is between three and five centimeters, instead of seven and eleven as in the first case. This is due to the batteries having become weakened by too constant use, a fact which was readily noticed by the force of the vibrations of the Wagner hammer. It will also be noticed that the gain per cent in radicles, by use of electric current, is not so high as in the first series. An average of the radicles of those lots of seeds which received the optimum strength of current is 4.66 centimeters, while the normals give an average of 4.08 centimeters, or a gain of 14.26 per cent, by treatment, a much lower figure than in the first tables. This seems to show quite conclusively that the beneficial effect of electrical stimulation, where applied but once, is very marked at first, but as the plants become matured this effect is partly, if not wholly lost.

A comparison of the growths of the hypocotyls and radicles shows that they both respond about alike to electrical stimulation. Although the gain per cent is not so high in every case, with the hypocotyls as the radicles, they follow in about the same proportion, and the optimum current is the same for both. An average of the lengths of the hypocotyls in those lots of seeds which received the optimum strength of current, gives 3.49 centimeters, while the normals give 3.11 centimeters or an increase of of 12.18 per cent by use of electricity, which is 1.55 per cent less than the gain in the length of radicles in the same lot of seeds.

An average of the number of seeds germinated in the various lots in tables IX.—XI. gives the following:

		Treated.	Untreated.	Gain per cent by treatment.
Average number seeds germinated in each lot in	24 hours,	13.33	11.33	17.65
	48 hours,	17.19	15 33	11.47
	72 hours,	18.43	18.00	2.38
	96 hours,	18.43	18.00	2.38

These results do not show so high a gain by use of electricity as in the first series, but prove that at the end of 72 hours all the seeds that retained vitality would germinate.

A COMPARISON OF DIFFERENT KINDS OF CURRENT. TABLES XII.—XVII.

In these experiments the seeds were treated with three forms of current. As in the foregoing tables, twenty-five seeds were used for each form of treatment, also the method of stimulation, the germination, the temperature and number of cells used were the same as previously described under Tables I.—IV., each lot of seeds being stimulated for a period of two minutes.

The first series of figures in each table represent the normal or untreated lots, the second represent the result of treating the seeds with an interrupted induced current from the Du Bois-Reymond coil, the secondary coil being seven centimeters from the primary, the distance which previous experiments had shown to give the optimum effect. In the third series the treatment was also with an interrupted induced current, the secondary coil as in the above case, but with this treatment the Wagner hammer was not connected, the wires being attached directly to the primary coil, and interruptions were made by making and breaking the circuit ten times. In the fourth form of treatment a direct current was used which was passed through the seeds directly from the battery.

In Tables XV.—XVII. the experiment was continued for 96 hours and the average lengths of the hypocotyls taken.

TABLE XII.

Effect of different kinds of current upon the germination and growth of the radicles of

WHITE MUSTARD (BRASSICA ALBA).

Kind of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	A v'ge length (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.
Normal plants (no current).	12	18	22	2.20	0
Interrupted Induced.	15	20	20	3.12	41.81
Induced 10 interruptions.	16	21	21	**3.33**	**51.36**
Direct.	14	20	20	3.08	40.00

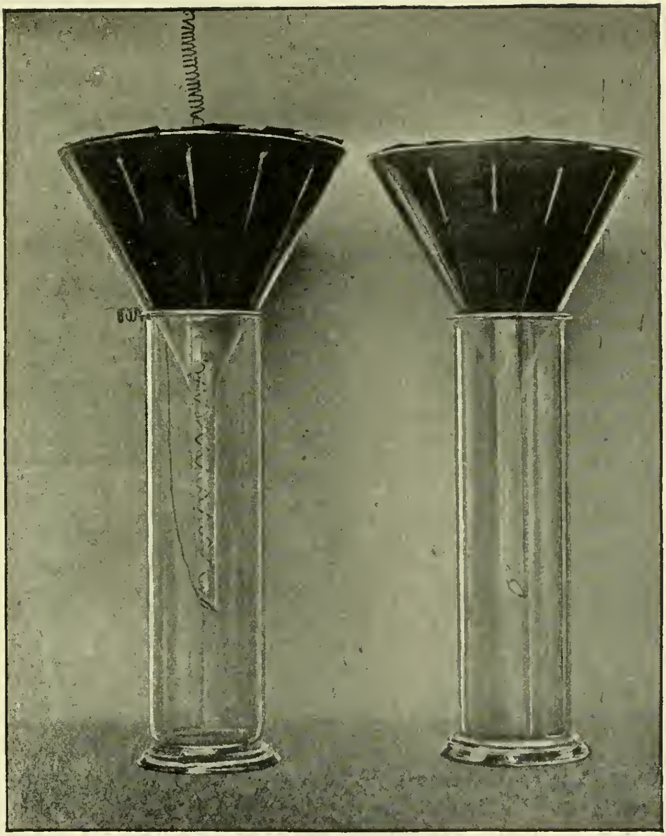


FIG. 3.

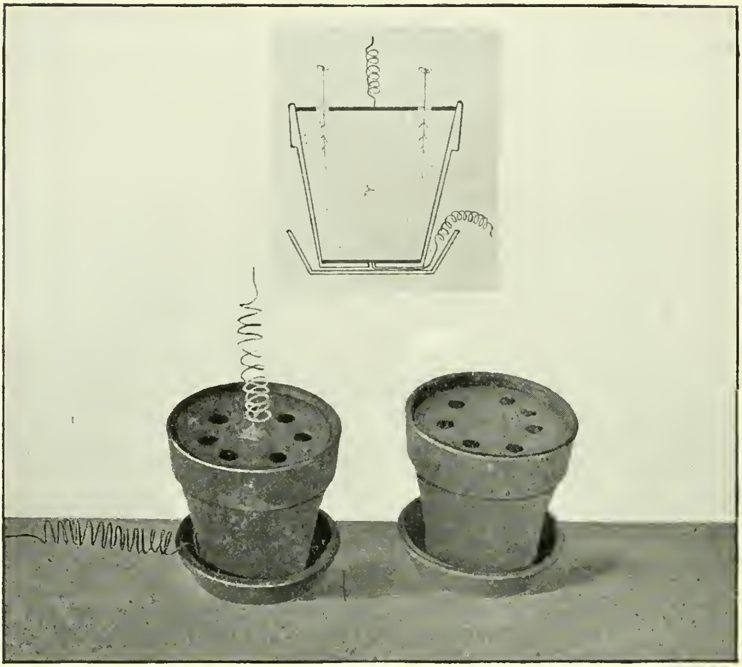


FIG. 4.

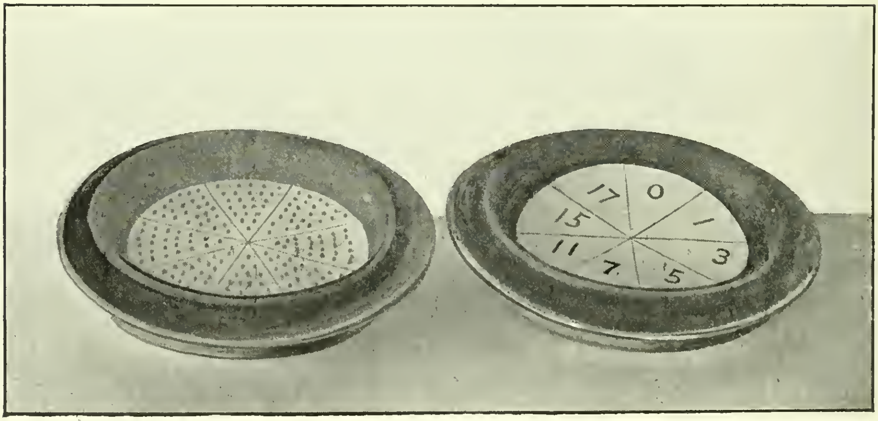

17
0
15
1
11
3
7
5

FIG. 5.

TABLE XIII.

Effect of different kinds of current upon the germination and growth of radicles of

RAPE (BRASSICA NAPUS).

Kind of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Av'ge length (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.
Normal plants (no current).	8	10	12	2.31	0
Interrupted Induced.	10	14	14	**3.83**	**65.80**
Induced 10 interruptions.	9	16	16	3.69	59.74
Direct	9	15	15	2.79	20 78

TABLE XIV.

Effect of different kinds of current upon the germination and growth of radicles of

RED CLOVER (TRIFOLIUM PRATENSE).

Kind of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Av'ge length (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.
Normal plants (no current).	12	18	21	1.35	0
Interrupted Induced.	14	20	22	**1.93**	**42.96**
Induced 10 interruptions.	15	22	22	1.78	31.85
Direct.	13	19	20	1.55	14.81

TABLE XV.

Effect of different kinds of current upon the germination and growth of radicles and hypocotyls of

WHITE MUSTARD (BRASSICA ALBA).

Kind of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Number seeds germinated in 96 hours.	Av'ge length (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.	Av'ge length (cent'm'ers) of hypocotyls at close of exper'm't	Per cent gain in hypocotyls by use of electricity.
Normal plants (no current).	15	18	21	21	6.19	0	3.33	0
Interrupted Induced.	17	19	19	19	**7.16**	**15.67**	**3.52**	**5.70**
Induced 10 interruptions	19	19	21	21	6.96	12.44	3.48	4.50
Direct.	18	20	20	20	6.30	1.77	3.37	1.20

TABLE XVI.

Effect of different kinds of current upon the germination and growth of radicles and hypocotyls of

RAPE (BRASSICA NAPUS).

Kind of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Number seeds germinated in 96 hours.	Av'ge length (in centimeters) of radicles at close of exper'm't	Per cent gain in radicles by use of electricity.	Av'ge length (cent'm'ers) of hypocotyls at close of exper'm't	Per cent gain in hypocotyls by use of electricity.
Normal plants (no current).	10	14	14	14	4.02	0	3.11	0
Interrupted Induced.	15	15	15	15	**4.54**	**12.93**	**3.45**	**10.93**
Induced 10 interruptions	13	14	14	14	4.40	9.45	3.40	9.32
Direct.	14	16	16	16	4.10	1.99	3.14	.96

TABLE XVII.

Effect of different kinds of current upon the germination and growth of radicles and hypocotyls of

RED CLOVER (TRIFOLIUM PRATENSE).

Kind of current.	Number seeds germinated in 24 hours.	Number seeds germinated in 48 hours.	Number seeds germinated in 72 hours.	Number seeds germinated in 96 hours.	Av'ge length (in centimeters) in radicles at close of exper'm't	Per cent gain in radicles by use of electricity.	Av'ge length (cent'm'ers) of hypocotyls at close of exper'm't	Per cent gain in hypocotyls by use of electricity.
Normal plants (no current).	20	22	24	24	1.80	0	2.45	0
Interrupted Induced.	22	24	24	24	**2.32**	**28.88**	**2.70**	**10.20**
Induced 10 interruptions	21	23	23	23	2.20	22.22	2.50	2.04
Direct.	22	24	24	24	2.12	17.77	2.48	1.22

The object of the above experiments has been to determine the effect of different forms of electric current upon germination. In order that more accurate conclusions may be drawn, an average has been taken of the various results under each form of treatment. The following table gives a summary of these results:

Average number of seeds germinated and the gain per cent by treatment in Tables XII.—XVII.

Kind of Current.	24 hours.		48 hours.		72 hours.	
	Number seeds germinated.	Gain per cent by treatment.	Number seeds germinated.	Gain per cent by treatment.	Number seeds germinated.	Gain per cent by treatment.
Normal	12.83	0	16.67	0	19.00	0
Interrupted induced	15.50	20.81	18.67	11.99	19.00	0
Inter'pt'd induced 10 interruptions	15.50	20.81	19.50	16.98	19.50	2.63
Direct	15.00	22.13	19.00	13.97	19 17	.89

Average growth of radicles and hypocotyls and gain per cent by treatment in Tables XII.—XVII.

Kind of Current.	Average growth (in centimeters) of radicles in 72 hours.	Gain per cent by treatment.	Average growth (in centimeters) of radicles in 96 hours.	Gain per cent by treatment.	Average growth (in centimeters) of hypocotyls in 96 hours.	Gain per cent by treatment.
Normal	1.95	0	4.00	0	2.96	0
Interrupted induced	2.96	51.79	4.67	16.75	3.22	8.78
Inter'pt'd induced 10 interruptions	2.93	50.25	4.52	13.00	3.13	5.74
Direct	2.47	26.66	4.17	4.25	2.99	1.01

It will be noticed from these results that the interrupted induced current where ten interruptions were used gave the highest percentage of germination, but the experiments have not been repeated enough times to definitely ascertain whether this will always follow. It will also be noticed that the interrupted induced current where the Wagner hammer was used gave a much longer growth of radicles and hypocotyls, and in fact this form of current has given the best results in all the experiments which were carried out.

Where the direct current was used, the gain was not so high as with the other forms. These experiments and others which have been made since, seem to prove that the optimum strength of direct current is of somewhat lower voltage than with the induced current, and that the cause of the low gain per cent in the tables is due to the fact that the optimum strength of direct current was not used.

Again it will be seen in these tables as in Tables I.—XI. that the percentage of germination at the end of 72 hours is much smaller than at 24 hours showing that germination was accelerated by treatment. Also the increase growth of radicles at the end of 96 hours was smaller than the increase growth in 72 hours which shows that the stimulating effect is gradually lost where the seeds are treated but once. The low percentage in gain in the hypocotyls is due to the same cause.

EFFECTS OF HOURLY TREATMENT

On Horse bean (Vicia faba, L.) and White Lupine (Lupinus albus, L.)

TABLES XVIII.—XIX.

Having satisfactorily determined that by stimulating the seeds before they were planted, an increase in the length of radicles could be obtained, the next question which presented itself was whether the growth of young plants could not be hastened, by subjecting them, at intervals, to the influence of the electric current.

For this work, the apparatus shown in Figure 3 was selected as it gave a good chance for examination of the radicles from time to time and in it the plants could easily be subjected to the electric current. One hundred seeds of the horse bean (Vicia faba) were sown in moist sawdust and allowed to remain there until the radicles had been pushed forth to a distance of about two centimeters when they were removed. From the hundred seeds, twenty-four were selected which seemed to nearest resemble each other. Upon the radicle of each of these was placed a dot of indelible ink one centimeter from the tip.

The glass funnels were filled with moist sand to within about an inch of the top as stated in the description of Figure 3. Twelve small holes were made in the sand along the inner surface of each funnel and in each of these holes a bean radicle was placed, the bean itself resting upon the surface of the sand. This having been done the funnel was filled with sand, covering the beans to a depth of about one-half inch. The copper discs were placed upon the sand and the plants treated. Figure 3 shows an apparatus set up in this way, the seeds in which, received hourly stimulation lasting about 30 seconds for a period of forty-eight hours.

The discs of one funnel were attached to the poles of the induction machine, the secondary coil being removed five centimeters, and a current was passed through hourly from a four Leclanché cell battery during the experiment. Measurements were taken of the radicles twice daily, the dot of ink being a constant point from which the increase could be determined. In the following table is given the average increase of the twelve radicles in each funnel, the measurements being taken twice daily for two days. A column of percentages is also given showing the gain by use of electrical stimulation.

TABLE XVIII.

Effect of hourly stimulation upon the growth of radicles of HORSE BEAN (VICIA FABA).

Time.	Treated.	Untreated.	Gain per cent by use of the electric current.
	Average increase in length of radicles in centimeters.	Average increase in length of radicles in centimeters.	
12 hours	1.87	1.57	19.11
24 hours	1.58	1.09	44.95
36 hours	2.53	1.78	42.13
48 hours	2.65	1.90	39.47

Having repeated the above experiment several times and obtained in each case practically the same results, it has been thought sufficient to publish but one table which is a fair representation of the results of the experiments carried out in this line.

In this table it will be noticed that in the first twelve hours the gain by treatment is not so great as at subsequent periods, a fact which has been seen in all of our other experiments in this line but the cause of which has not been fully ascertained. Along this same line were conducted some experiments upon the growth of the hypocotyls where they were subjected to hourly electrical stimulation. For this work the apparatus shown in Figure 4, which has been previously described, was used.

In each pot seven seeds of the White lupine (Lupinus albus) were sown. These were stimulated hourly, for a period of about thirty seconds at each treatment, for fourteen days, with the same strength of current as was used in the foregoing experiment. Measurements were then taken of all the hypocotyls in each pot and an average made which is given in the following table:

TABLE XIX.

Effect of hourly stimulation upon the growth of stems (hypocotyls and epicotyls) OF WHITE LUPINE (LUPINUS ALBUS).

	Treated.	Untreated.	Gain percent by treatment.
Average growth	18.52	15.13	22.40

This experiment, as do others which have been made but which are not recorded in this work, shows a decided increase by treatment proving conclusively that the beneficial effect of electricity upon growing plants is quite constant.

SUMMARY.

1. Electricity exerts an appreciable influence upon the germination of seeds.

2. The application of certain strengths of current to seeds for short periods of time accelerates the processes of germination.

(a). As a result of experiment it has been found that at the end of twenty-four hours over thirty per cent more seeds were germinated in the treated lots than in the normal. At the end of forty-eight hours about twenty per cent and in seventy-two hours six per cent.

3. Those lots of seeds, receiving electrical stimulation gave a higher percentage of germination than the normal.

4. The range in the strength of current which accelerates germination is exceedingly limited.

5. The effect of electricity upon the germination of seeds shows that there is a maximum, optimum and minimum current.

6. The minimum strength of current which just perceptibly accelerates germination when an interrupted induced current is used, is quite close to number 17 in the tables and probably represents considerably less than one volt.

7. The optimum strength of current which shows the maximum growth of radicles and hypocotyls is equal to about 3 volts where an interrupted induced current is used.

8. The maximum current which the seed germ can withstand without being destroyed has not been ascertained in these experiments but probably represents a comparatively high voltage.

9. The optimum strength of current is practically constant for such small seeds as mustard, red clover, etc.

10. The optimum current for radicles and hypocotyls is the same.

11. Seeds subjected to but one application of electricity show the effect only for a few hours.

(a). In those lots of seeds which received an optimum strength of current, an increase of over thirty per cent in the length of radicles was found at the end of seventy-two hours, while at the end of ninety-six hours this increase was less than fifteen per cent showing that the beneficial effect was lost as the plants matured.

(b). The gain in the hypocotyls by use of an optimum current was about thirteen per cent or a little less than that of the radicles in the same lots of seeds.

12. Electricity when applied hourly to germinating seeds or growing plants, does not lose its effect but acts as a constant stimulation to their growth and development.

HATCH EXPERIMENT STATION

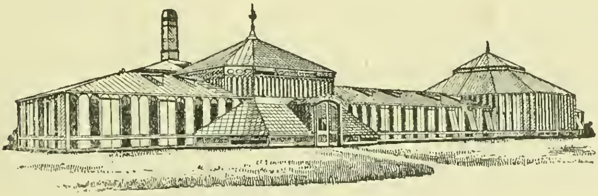
OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 44.

VARIETY TESTS OF FRUITS.

TESTS OF VEGETABLE SEEDS.



DURFEE PLANT HOUSE.

MARCH, 1897.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1897.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, " Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

HENRY H. GOODELL, LL. D.,	*Director.*
WILLIAM P. BROOKS, B. SC.,	*Agriculturist.*
GEORGE E. STONE, PH. D.,	*Botanist.*
CHARLES A. GOESSMANN, PH. D., LL. D.,	*Chemist* (Fertilizers).
JOSEPH B. LINDSEY, PH. D.,	*Chemist* (Foods and Feeding).
CHARLES H. FERNALD, PH. D.,	*Entomologist.*
SAMUEL T. MAYNARD, B. SC.,	*Horticulturist.*
LEONARD METCALF, B. S.,	*Meteorologist.*
HENRY M. THOMSON, B. SC.,	*Assistant Agriculturist.*
RALPH E. SMITH, B. SC.,	*Assistant Botanist.*
HENRI D. HASKINS, B. SC.,	*Assistant Chemist* (Fertilizers).
ROBERT H. SMITH, B. SC.,	*Assistant Chemist* (Fertilizers).
EDWARD B. HOLLAND, B. SC.,	*Ass't Chemist*(Foods and Feeding).
FRED W. MOSSMAN, B. SC.,	*Ass't Chemist*(Foods and Feeding).
ROBERT A. COOLEY, B. SC.,	*Assistant Entomologist.*
JOSEPH H. PUTNAM, B. SC.,	*Assistant Horticulturist.*
STEPHEN W. FLETCHER, B. SC.,	*Assistant Horticulturist.*
BENJAMIN K. JONES,B. SC.,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

HATCH EXPERIMENT STATION, Amherst, Mass.

Summary of the Work

OF THE

HORTICULTURAL DIVISION FOR 1896.

S. T. MAYNARD, J. H. PUTNAM AND S. W. FLETCHER.

Variety Tests of Fruits.

Apples.

A majority of the varieties in the station orchard fruited heavily the past season and afforded an excellent opportunity for comparison. Of the older and standard varieties, the following produced excellent crops, and sustained the position which has been accorded to them in the commercial orchard.

Summer.—Early Harvest, Red Astrachan, Sweet Bough, Williams.

Autumn.—Chenango, Fameuse, Fall Pippin, Gravenstein, Hurlbut, Maiden's Blush, Oldenburg, Porter.

Winter.—Baldwin, Ben Davis, Lady Apple, Mother, King, Red Russet, Rhode Island Greening, Roxbury Russet, Swaar, Westfield. Of these the Hurlbut, Ben Davis, Swaar and Roxbury Russet were exceptionally fine. Of the other varieties either new or less generally known which have fruited the past season are the following; Alexander, Arabskoe, Benoni, Dutch Codlin, English Codlin, Haas, Shiawasse, Stump, Summer Pippin (Nyack Pippin), Sutton Beauty, Tetofsky, Walbridge, Carlough, Lawver (Delaware Winter), Palmer Greening, Gam, Gen. Lyon, Indian Cion, Lankford, Orange Pippin, Ord Beni, Salome, Switzer, Scarlet Cranberry, Wealthy, Titovka, Whinnery's Late, etc. Those showing especial merit in this list are:

Wealthy. The fruit is large, perfect in form and color and of fine quality. The tree is vigorous and productive and free from disease.

Shiawasse. A variety much resembling the Fameuse, but larger and about equal in quality. It has shown something of the defects of the latter variety in growing irregular. It promises to be valuable under conditions where the Fameuse is successfully grown.

Sutton Beauty. Specimens of this variety were rather larger than usual, very perfect in form and color. When grown on rich land and the fruit properly thinned, it is of good size and its beauty and quality is sure to increase the demand for it as it becomes better known.

Palmer Greening. The young trees of this variety bore only a few specimens, which were of unusual size and well colored. As with the last variety its quality will increase the demand for it as it becomes better known.

Ord Beni. An apple medium to large in size, of beautiful color and very promising.

Titovka. Of large size, rather coarse in grain and quality, but as it can be put on the market with the Early Harvest it may prove valuable for cooking.

Lawver (Delaware Winter). Although an old variety, few varieties give promise of more value than this. It is of medium to large size, brilliantly colored all over with bright crimson, very fine in texture, of fair quality and a very late keeper. It is much better in quality than the Ben Davis and promises to be as good a keeper.

Walbridge. A very handsome apple of medium to large size and good quality. It is productive and a good keeper.

Red Russet. This variety bears heavily and the fruit when thinned is of good quality, intermediate between the Baldwin and Roxbury Russet. It is claimed to be a graft hybrid between the two. The past season it produced perfect specimens of the distinct Baldwin type with no Russet markings, specimens of the perfect russet type with no red markings, and the type of the variety, having both red and russet markings.

Grapes.

Nearly all the varieties of grapes in the experiment vineyard made a fine growth during the season of 1895, although they bore a heavy crop of fruit. Many of the less hardy varieties were, however, so badly injured by the winter, that the crop of the present season was light and uneven, while the commercial vineyard which contains mostly Concords with a few other hardy varieties produced a very good crop.

In most cases there are two vines of each variety, one of which has been sprayed, for several seasons, while the other has been left unsprayed. There was a very marked difference in the hardiness of the sprayed and unsprayed vines of the same variety. In many cases the sprayed vine bore a good crop while the unsprayed was barren. The cause of this is apparent. The sprayed vines being free from disease hold their foliage longer and are thus enabled to ripen their wood and develop their buds to a greater extent than those which lose their leaves while the wood is green and the buds are immature. It is unquestionable that ripe wood and mature buds are less liable to injury by frost than green wood and immature buds. The beneficial effects of proper spraying are even more noticeable in the crop of the year following the treatment than at the time of application. In 72 of the varieties in the following table, the 72 sprayed vines produced 725 clusters weiging 187 pounds, while the 72 unsprayed produced 473 clusters weighing 118 pounds, 4 ounces.

Where only one vine of a variety was grown it was sprayed and the place for the unsprayed vine in the table is filled by a dash. The presence of an unsprayed vine that bore no fruit is denoted by a zero.

GRAPES (BLACK).

VARIETY.	Species.	Date of coloring.	Date of ripening.	Vigor.	Hardiness.	Resistance to disease.	Quality.	No. of bunches sprayed vine.	No. of bunches unsprayed vine.	lbs. oz. Total weight sprayed vine.	lbs. oz. Total weight unspray'd vine	oz. Weight of largest bunch.	Adhesiveness.	Keeping qualities.
Adirondac,	Labr.	Aug. 16	Sept. 2	8	9	8	7	24	–	6–8	–	3.5	4	4
Aminia, (R.39.)	Labr.-hybr	“ 16	“ 16	8	10	9	8	7	15	1–3	4–11	9	9	9
Arnold's No. 2,		“ 14	“ 18	8	8	10	7	1	0	–3	0	3	8	8
August Giant,	Rip.-hybr.	“ 16	“ 16	9	7	9	5	8	0	1–14	0	5	10	5
Bacchus,	Rip.	“ 25	“ 16	10	10	9	6	2	0	–8	0	5	10	9
Barry, (R. 43,)	Labr.-hybr.	“ 16	“ 17	8	8	8	8	11	–	1–3	–	4	10	10
Canada, (A.16,)	Rip.-hybr.	“ 26	“ 22	7	0	9	6	16	6	7–3	1–12	12	9	8
Champion,	Labr.	“ 11	“ 2	9	8	9	4	5	0	–10	0	3	8	2
Clinton,	Rip.	“ 17	Oct. 10	9	10	10	6	28	20	5–1	3–7	7	10	7
Concord,	Labr.	“ 22	Sept. 10	10	10	10	8	15	–	7–8	–	17	8	4
Cottage.	Labr.	“ 17	“ 10	6	10	8	7	4	0	1–4	0	8	7	2
Cynthiana,	Æst.	“ 2	“ 20	6	10	9	5	15	0	1–8	0	4	7	6
Early Victor,	Labr. x	“ 10	“ 4	6	9	9	5	7	8	–9	–14	1.8	8	4
Eaton,	Labr.	“ 22	“ 18	9	7	9	6	4	0	2–9	0	21	3	2
Elsinburg	Æst.	“ 21	“ 14	8	8	9	5	20	–	2–11	–	3.5	9	8
Herbert, (R.44,)	Labr.-hybr	“ 17	“ 14	10	9	8	9	14	12	8–5	7–6	17	10	10
Herman Jaeger,		“ 12	“ 21	8	10	10	7	6	11	–7	–12	1.5	8	7
Janesville,	Labr.	“ 6	Aug. 26	7	10	8	4	20	14	3–10	4–2	8	6	6
Jewel,	Æst. x	“ 12	“ 28	8	10	9	9	20	–	3–0	–	4	8	8
Merrimac(R.19)	Labr.-hybr	“ 15	Sept. 16	10	10	9	8	7	10	3–1	3–11	13	10	10
Montifore,	Rip. x	“ 17	“ 10	7	9	10	5	16	14	3–7	3–14	6	8	6
Nectar,	Labr.-hybr	“ 26	“ 16	6	8	9	9	6	–	–15	–	4	8	7
Norman,		“ 17	“ 15	7	9	9	8	7	0	1–6	0	3	6	6
Peabody,	Rip. x	“ 11	Aug. 29	10	9	9	8	9	–	5–11	–	13	8	8
Rogers No. 32,	Labr.-hybr	“ 16	Sept. 15	9	9	7	7	10	7	2–11	1–1	5	10	9
Rogers No. 33,	Labr.-hybr	“ 16	“ 16	9	8	8	8	5	3	1–3	–11	7	7	8
Rogers No. 34,	Labr.-hybr	“ 16	“ 18	10	10	7	8	12	10	4–8	5–2	13	8	9
Secretary,	Rip.-hybr.	“ 21	“ 29	8	9	8	7	17	–	3–15	–	5	10	10
Seedling A.,	?	“ 20	“ 6	8	10	10	8	6	–	1–7	–	5	8	6
Seedling 14,	?	Sept. 4	“ 23	7	9	8	7	12	–	1–7	–	4	7	8
Seedling 15,	?	Aug. 23	“ 10	9	10	9	8	12	–	4–10	–	12	8	8
Seedling 18,	?	“ 21	“ 10	9	10	9	8	14	–	4–4	–	10	8	8
Standard,		“ 15	“ 10	8	10	10	8	15	–	3–11	–	8	7	8
Stayman's 47,		“ 25	“ 25	9	10	10	8	11	16	4–5	7–1	12	7	7
Wilder, (R. 4,)	Labr.-hybr	“ 20	“ 12	10	9	8	10	10	2	7–8	–8	18	10	10
Worden,	Labr.	“ 26	“ 7	8	10	9	9	14	21	4–12	6–8	11	4	3

GRAPES (RED).

VARIETY.	Species.	Date of coloring.	Date of ripening	Vigor.	Hardiness.	Resistance to disease.	Quality.	No. of bunches sprayed vine	No. of bunches unsprayed vine.	lbs. oz. Total weight sprayed vine.	lbs. oz. Total weight unspray'd vine	oz. Weight of largest bunch.	Adhesiveness.	Keeping qualities.
Agawam (R.15)	Labr.-hybr	Aug. 12	Sept. 24	8	8	7	8	7	-	1-5	-	5	9	9
Beauty,	Æst.-hybr.	“ 21	“ 16	8	10	10	8	7	-	-13	-	3	8	8
Berckmans,	Rip.-hybr.	“ 18	“ 24	9	10	9	8	13	17	5-14	6-6	11	9	9
Brighton,	Labr. x Vin	“ 19	“ 16	7	8	6	10	5	0	1-6	0	7	9	9
Brilliant,	Labr.-hybr	“ 16	“ 10	8	9	9	9	5	45	1-4	3 12	8	8	6
Charter Oak,	Labr.	“ 24	“ 18	9	10	10	4	14	-	2-6	-	3	4	3
Delaware,	?	“ 16	“ 4	8	9	7	10	14	-	4-2	-	5.5	8	7
Dela're Muscat	?	“ 16	“ 10	7	8	10	5	12	0	1-2	0	1.5	8	5
Essex, (R. 41,)	Labr.-hybr	“ 20	“ 19	7	10	7	8	8	10	2-12	1-10	7.5	9	9
Excelsior,	Labr.-hybr	“ 11	not ripe	6	6	7	8	3	0	-14	0	6	9	3
Ideal,	Æst. x	“ 26	Sept. 16	8	9	8	9	20	14	5-4	4-2	9	4	4
Iowa,	Labr.	“ 20	Oct. 5	8	9	8	10	8	-	3-3	-	7	10	10
Lee's Prolific,	Labr.	“ 15	Sept. 16	9	10	8	7	12	15	2-8	1-8	5	8	7
Lindley, (R.9,)	Labr.-hybr	“ 15	“ 19	9	8	7	9	12	4	2-8	-7	5	8	7
Massasoit (R.3)	Labr. hybr	“ 8	“ 19	9	9	5	8	6	0	2 8	0	10	10	10
Moyer,	Æst.-hybr.	“ 15	Aug. 31	7	10	8	8	14	21	1-4	2 8	3.5	6	5
Norfolk,	Labr.-hybr	“ 22	Sept. 10	9	7	4	8	9	5	2-7	1-4	7	8	8
North'n Musc't	Labr.	Sept. 7	“ 27	9	9	8	5	14	0	3-12	0	9	6	5
Oneida,	Labr.-hybr	Aug. 26	“ 20	7	7	4	8	6	0	1-12	0	6.5	9	9
Oriental,	Labr..hybr	“ 25	“ 25	8	9	8	8	11	-	2-7	-	6 5	9	9
Perkins,	Labr.	“ 17	“ 18	9	9	8	6	18	6	5-12	1-12	10	3	3
Requa, (R. 28,)	Labr.-hybr	“ 20	“ 10	9	9	8	8	11	0	3-11	0	10	9	9
Rochester,	Labr. x	“ 18	“ 18	6	8	6	8	6	-	2 10	-	8	4	5
Roger's No. 30,	Labr.-hybr	“ 15	“ 21	8	10	8	7	18	15	4-10	4-12	9	8	8
Salem, (R. 53,)	Labr.-hybr	“ 31	“ 18	9	8	5	9	4	0	1-4	0	7	9	9
Seedling 19,	?	“ 12	“ 16	9	9	8	7	11	-	1-6	-	3	2	2
Stayman's 3,		“ 13	“ 30	9	10	10	7	4	7	1-4	-14	6	7	
Ulster,	Labr. x	“ 31	“ 24	6	8	8	8	7	2	1-9	-7	7	8	9
Vergennes,	Labr.	“ 16	“ 18	7	8	4	9	6	4	1-11	-7	7	10	10
Walter,	Æst. x Lab.	“ 31	Oct. 2	10	6	7	7	2	0	-4	0	3	8	8
Woodruff Red,	Labr.	“ 15	Sept. 16	8	10	10	7	14	20	1-15	2-13	5	5	7
Wyoming Red,	Labr.	“ 15	“ 16	8	10	10	8	7	0	-13	0	3.5	5	7

GRAPES (WHITE).

VARIETY.	Species.	Date of ripening.	Vigor.	Hardiness.	Resistance to disease.	Quality.	No. of bunches sprayed vine.	No. of bunches unsprayed vine.	Total weight sprayed vine. lbs. oz.	Total weight of unspray'd vine lbs. oz.	Weight of largest bunch. oz.	Adhesiveness.	Keeping qualities.
Antoinette,	Labr.	Sept. 18	7	8	10	7	8	0	-14	0	3.5	5	5
Augusta,	Labr.	" 20	6	10	8	5	20	20	11- 6	8 14	17	3	4
Bertha,	Labr.	" 26	8	8	8	7	7	—	1-14	—	4	5	4
Colerain,	Labr.	" 14	4	8	8	9	3	0	- 5	0	2	7	6
Concord Muscat,	Labr.	" 28	9	9	8	6	16	0	4-10	0	8	5	2
Elvira,	Rip.-hybr.	" 26	9	10	7	7	8	0	6-12	0	14	7	6
Emma,	Labr.	" 10	7	9	7	8	10	—	1- 6	—	3	2	2
Esther,	Labr. x	" 20	7	10	9	6	14	9	4- 3	3- 5	5	10	5
Etta,	Rip.	" 29	9	8	9	6	17	9	3- 3	1- 5	5	4	5
Faith,	Rip. x	" 5	6	10	10	9	7	12	1- 8	2- 4	4	5	2
Geneva,	Labr.-hybr	" 18	7	10	10	8	22	0	3-10	0	5	9	8
Golden Drop,	Labr.-hybr	" 16	8	10	9	9	3	8	-15	-12	3.5	7	7
Golden Gem,	Æst.-hybr.	" 15	7	9	8	9	12	11	1- 2	-15	1.5	4	4
Grein's Golden,	Rip.-hybr.	" 22	7	10	8	7	5	—	2- 1	—	10	6	4
Grein's No. 2,		" 20	6	9	9	6	15	0	2- 4	0	4.5	6	5
G. W. Campbell,		" 18	8	9	9	9	2	0	- 4	0	2.5	8	8
Hayes,	Labr.	" 15	7	7	6	8	12	0	1- 4	0	4	2	2
Jessica,	Vin. ?	" 12	7	8	8	9	4	11	- 7	2- 5	3.5	4	4
Lady,	Labr.	" 12	7	8	8	9	4	0	- 7	0	3	5	2
Maria Louise,	Labr.	" 17	6	10	9	8	10	0	1- 1	0	3.5	8	7
Moore's Diamond	Labr. x	" 12	9	9	10	10	11	12	4- 2	2-11	7	7	6
Prentis,	Labr.	" 17	8	9	9	8	8	11	1- 7	1-13	7	7	8
Rebecca,	Labr.	" 22	6	7	7	10	5	0	-11	0	6	10	9
Staymans' No. 4,	Labr.	" 20	8	9	10	7	10	24	1-14	6- 9	6.5	6	6
Staymans' No. 42,		" 26	10	10	9	8	10	4	2- 1	- 9	4	7	6
Staymans' No. 44,		" 12	10	10	10	9	8	8	1-12	-15	3	7	8
Transparent,	Rip. x	" 24	8	10	9	7	30	0	3-15	0	5	8	7
Winchell,	Labr.	Aug. 25	7	9	9	10	8	10	2- 7	2- 1	9	8	6
Witt,	Labr.	Sept. 16	7	9	9	8	11		-13		5.5	8	7

The following varieties were so badly injured by the winter that that they did not produce any fruit: Arnold's No. 1, Black Eagle, Caywood's No. 50, Creveling, Highland, Mills, Rockwood, Centennial, Diana, Jefferson, Amber, Belinda, Duchess, Eldorado, Empire State, Pearl, Triumph, Victoria and Wilding.

Among the new varieties that have fruited may be mentioned the following:

Brilliant. Vine a moderately vigorous grower, not quite hardy, but little subject to disease. Bunch and berry medium size, of good quality, skin thick, tough, of a brilliant red color. Season a little later than the Delaware; promising.

Emma. Vine not very vigorous, quite hardy and subject to disease. Bunch small, berry medium, of a bright yellow color. Quality good, drops from bunch badly, a poor keeper. Of no special value.

Geneva. Vine moderately vigorous, very hardy and free from disease. Bunches medium, loose, berries large, light yellow color, quality good, but not the best, adheres well and is an excellent keeper, very productive, ripening a little earlier than the Concord. Promising on account of its hardiness, freedom from disease and good shipping qualities.

Herman Jaeger. Very disappointing. Bunches averaged but little more than one ounce each, and the quality could not be called good.

Maria Louise. Vine rather weak grower, very hardy and but little subject to disease. Bunch good size, shouldered, compact, berries medium size, color white, skin thin, good quality. A good grape, but unlikely to prove of any great value.

Gooseberries.

Number of varieties tested twenty-one. The gooseberry experiment plots were set out in the spring of 1893, and have borne two full crops. The varieties in bearing, number seventeen, and four more will fruit for the first time this year. Each variety includes ten plants, set three feet apart in the row. For commercial culture the distance apart should vary with the variety. Vigorous American varieties should be set in rows not less than six feet apart, and four feet in the row. Less thrifty English varieties may be three by five feet, the rows far enough apart to allow of horse cultivation. On the latter, but little pruning will be required except to trim out dead wood and superfluous shoots, but with vigorous native varieties it is best to remove some of the old canes as they become weak, and shorten the new growth each year.

The following table gives a synopsis of the field observations on the different varieties :

VARIETY.	Vigor.	Season.	Quality.	Size.	Productiveness.
Champion,	8.5	m	7.5	7.5	9
Chautauqua,	8	l	8.5	9	8
Columbus,	8.5	l	8	8.5	8.5
Crown Bob,	8	m	8.5	8	8.5
Downing,	10	m	8	7.5	9.5
Golden Prolific,	8	m	7	8.5	8
Houghton,	9	m	8	6.5	8.5
Industry,	7	m	9.5	8.5	7.5
Keepsake,	8	e	7.5	8	8
Lancashire Ladd,	7	e	8	8	7.5
Lewis Roesche,	9.5	m	9.5	10	9.5
Pale Red,	9.5	e	8	7	9
Pearl,	9	m	7.5	7	8.5
Red Jacket,	8	l	8.5	8	8.5
Smith's Improved,	8.5	m	7.5	8	8
Triumph,	9	l	8	9.5	9
White Smith,	7	m	8	8.5	8.5

Explanation : e, early ; m, medium ; l, late.

American Varieties.

Champion. Bush fairly vigorous and productive, berry small, oval, downy, light green, of only fair quality.

Chautauqua. Probably an American seedling of the English type. A vigorous, upright grower, fairly productive ; berry large to very large, oval, pale yellow ; skin thick, smooth ; quality good.

Columbus. American seedling of the English type. Bush vigorous and productive ; berry large, oval, very spicy ; skin thin, smooth, greenish yellow ; quality good. A desirable variety.

Downing A seedling of the Houghton, and the standard for vigor and productiveness. Berry medium, roundish oval ; skin thin, light green with white bloom; quality good. Bush and berry usually free from disease. An excellent variety for home or market culture.

Golden Prolific. American seedling of an English variety. Bush moderately vigorous and productive, very spiny; berry large, oval; skin thick, golden yellow, with long scattered bristles; quality poor.

Houghton. An old standard variety, vigorous and productive. Berries small, round; skin smooth, light green with dull red cheek, and white bloom. Quality good.

Lewis Roesche. Probably an American seedling of the English type. Bush upright, very vigorous and productive; berry uniformly very large, oval; skin thin, smooth, pale yellow; quality excellent. A remarkably fine variety.

Pale Red. Origin unknown. A very thrifty grower and good bearer. Berries of medium size, round, perfectly smooth; skin very thin, crimson, with white bloom, handsome; flesh very firm, of good quality. The earliest variety to ripen here.

Pearl. Very similar to Downing, but inferior to that variety in vigor, productiveness and size of berry.

Red Jacket. American seedling. Medium in productiveness and vigor; berries medium, round; skin thick, smooth; quality good.

Smith's Improved. A Houghton seedling of medium vigor and productiveness. Berries large, oval, smooth; skin thin, greenish yellow; quality fair.

Triumph. American seedling. Bush very vigorous and productive; berries large to very large, round, with down pubescence; color light greenish yellow; quality good. A very promising variety.

English Varieties.

Crown Bob. Bush small, upright, medium in productiveness and vigor; berries medium to large, round oval, dark crimson, hairy, of good quality. One of the best of the English varieties.

Industry. With us this variety is deficient in vigor and only moderately productive. Berries average large, round oval, dark crimson; skin rather thick with scattered long bristles. Quality excellent. A remarkably handsome berry of the very best quality, yet it cannot be recommended for extensive culture. One of the finest, however, for the home garden.

Keepsake. Bush compact, fairly productive and vigorous; berry round, smooth, light green; flesh soft, quality below medium.

Lancashire Ladd. Lacking in vigor and productiveness. Berry medium, oval, dark crimson, handsome, good quality. One of the first to ripen here.

White Smith. A weak grower, but moderately productive; berry large, round oval, light greenish yellow, pubescent; quality fair.

Four varieties of "spineless" gooseberries, Souvenir de Billard, Transparent, Belle de Meaux and Ed Lefort, show little vigor of growth but may fruit for the first time this year.

From observations thus far we would place Lewis Roesche, Triumph, Downing, Columbus, Chautauqua and Crown Bob as the six best varieties, in the order named. The characteristics of varieties vary so greatly with soil and location, that those varieties giving good results here might prove worthless elsewhere; but we believe these six to be, on the whole, most valuable for general culture.

As a class, the English varieties are deficient in vigor and productiveness, and very susceptible to disease. The uniformly cool and moist climate of the British Isles develops these varieties to perfection, but the extremes of temperature and humidity in America are unfavorable. Many very fine English varieties are worthless here, because the mildew so readily attacks them.

Purely native varieties like the Downing, are nearly the perfection of productiveness and vigor, but lack in quality and size of berry.

Currants.

Number of varieties tested twenty-five. Experiment work with currants dates from the spring of 1892 when two varieties were planted. The following year, fifteen more varieties were added, and, in the spring of 1896, eight, making a total of twenty five now under cultivation. Of these, seventeen are in bearing, and a report can be made on their comparative value. Each variety of the red and white currants includes ten plants, set in rows six feet apart, and four feet in the row. The varieties of black currants are planted between the rows of a young apple orchard, but have had ample room for development. The soil of both plots is a mellow loam. Clean culture and adequate fertilization have been given from the start. The following table scores the comparative value of each variety as it fruited on the station-grounds, ten indicating perfection.

VARIETY.	Vigor.	Size of bunch.	Size of berry.	Quality.	Productiveness.
RED: Cherry,	9.5	8	9	9	9
Fay's Prolific,	9.5	9	9.5	9	9
Knight's Improv'd	9	9.5	9	9	8.5
London Red,	8	9.5	8.5	7.5	8
*Moore's Selected,	9	9	9.5	8.5	8.5
*North Star,	10	8	7.5	9	9.5
Prince Albert,	8.5	8	8.5	7.5	8.5
Versailles,	9.5	8	9	9	9
Victoria,	9	7.5	7.5	7.5	8
WHITE: White Dutch,	9	7.5	8	8	7.5
White Grape,	8.5	9.5	9	7	7
BLACK: Champion,	9	9	9	9	8 5
Black English,	8.5	9	8.5	8.5	7.5
Black Naples,	8.5	8	7.5	8.5	7.5
Black Seedling,	10	9	8.5	7	7
Crandall,	10	6.5	10	6	6 5
Lee's Prolific,	8	7.5	8	8	7

*Set in 1892; all others in 1893.

Black-caps. Raspberries.

The crop of Black-caps was very fair but not as good as in 1895. Kansas, Lovett, Hilborn and Ohio continue to hold their places as first class market berries. Following, are a few notes on some of the most promising new varieties :

Brackett's Seedling. The results of this year confirm the previous good reports of this berry. It equals the Kansas in productiveness, is larger and ripens a few days later.

Eureka. Fruited here for the first time. Fruit medium size; fair quality ; not very firm. The most productive of the early berries and worthy of a trial.

Gault. Fruited here for the first time, and promises to be productive. It failed to disclose any of the wonderful fall-fruiting qualities advertised by its introducer.

Wade. Fruited here for the first time. It is a very large firm berry of the best quality. Productive and promising.

BLACK-CAPS.

VARIETY.	Date of ripening.	Vigor.	Quality.	Size.	Firmness.	Yield for 25 plants. Qts.	% of canes winterkilled.
Ada,	July 4	9	8	m	f	17½	12
Brackett's Seedling,	June 30	9	8	l	f	56¼	9
Carmen,	“ 28	7	8	m	mf	17⅛	9.5
Cluster,	“ 23	8.5	8.5	m	f	21¼	2
Corinth,	“ 25	8.5	8 5	l	mf	27½	7
Cromwell,	“ 21	7	8.5	m	f	13¾	0
Earheart,	“ 24	9	9	m	f	12½	10
Eureka,	“ 23	8	8	m	ms	31¼	0
Gault,	July 6	9	8	m	f	26	8
Green's New Raspberry,	“ 1	8	7.5	l	f	26	10
Hilborn,	June 29	9.5	9.5	l	f	30½	0
Howard's Seedling,	July 1	7.5	9	s	f	20½	10
Kansas,	June 27	8.5	8	m	f	56½	7
Lovett,	“ 26	9	9	m	mf	24¼	0
Ohio,	“ 27	9	8.5	m	f	21¾	5
Older,	“ 28	8.5	7.5	l	mf	45	6.5
Smith's Prolific,	“ 30	7.5	8	m	f	18¾	0
Souhegan,	“ 22	8.5	9	s	f	16⅔	8
Springfield,	“ 20	9	8.5	s	mf	8⅓	15
Wade,	July 2	8	9	l	f	35	5
Columbian,	“ 5	9.5	7	m	mf	21¾	0

Red Raspberries.

Every alternate five hills of raspberries were laid down and the tips covered with soil to hold them in place. This was done about the middle of November. In nearly all cases those thus protected came through the winter safely, while those unprotected were severely injured.

RASPBERRIES.

VARIETY.	Date of ripening.	% of canes winter-killed.		Vigor.	Quality.	Size.	Firmness.	Yield from 25 plants.
		Cover'd	Not covered					Qts.
Cuthbert,	July 5	10	50	9.5	8	ml	mf	16⅔
Gladstone,	June 23	10	40	8.5	7.5	m	f	6
Golden Queen,	July 6	20	70	7	8 5	vs	s	18½
Hansel,	June 20	10	75	7.5	8.5	m	mf	6
King,	July 2	08	40	9	8.5	m	f	7
Loudon,	“ 3	00	10	9	9	l	f	49½
Marlboro',	June 22	10	50	7	8	l	f	5
Miller,	July 6	00	25	8	8.5	m	mf	12½
Royal Church,	“ 3	15	85	8	9	l	vs	18
Stayman's No. 5,	“ 5	00	10	8	8.5	m	mf	3¾
Thompson's Early Prolific,	June 27	20	80	8	7.5	m	mf	8
Thompson's Pride,	“ 25	10	35	8	8	m	mf	19½
Victor,	July 4	60	85	9.5	9	l	f	2⅔

Crimson Beauty, Naomi, Rancocas and Scarlet Gem have been discarded as valueless. Gladstone, Thompson's Prolific and Victor are of little value here.

King. This is a vigorous variety, but was much injured by the winter and was not productive.

Loudon. A very vigorous and productive variety. It was very little injured by the past winter,while many of the standard varieties suffered severely. Fruit large, firm, bright crimson; quality, best. The most promising variety in the station collection.

Miller. Moderately vigorous and productive. It is above the average in hardiness, but the uncovered canes were considerably injured; promising.

The older varieties retain about the same relative position, and their descriptions may be found in former reports.

Blackberries.

The blackberry crop of the past season was very good, the hardier varieties suffering but little from winter-killing.

BLACKBERRIES.

VARIETY.	Date of ripening.	Vigor.	Quality.	Size.	Yield from 25 plants. Qts.	% of canes winterkilled.
Agawam,	July 9	9	8.5	m	26⅔	5
Early King,	" 6	8.5	9	ml	2	70
Eldorado,	" 10	9	8.5	m	26½	15
Erie,	" 14	8.5	8.5	l	8¾	60
Fred,	" 15	8	8.5	m	3¼	30
Hoosier,	" 9	8	9	l	30	8
Lovett's Best,	" 12	9	8.5	ml	2½	5
Minnewaski,	" 11	8	9	l	10	70
Ohmer,	" 16	9	7.5	vl	14	20
Snyder,	" 10	5	8	ms	40½	00
Stone's Hardy,	" 10	8.5	8	l	4¼	25
Taylor,	" 14	9	8	m	25½	5
Topsy,	" 16	8	8	m	3½	80
Wachusett,	" 10	8	8	m	7	20
Western Triumph,	" 16	8	9	l	2¼	20
Wilson,	" 14	8.5	8	m	4	20
Woodford,	" 16	8	8.5	l	8	10

Early King, Erie and Minnewaski have not proved sufficiently hardy to be of any value for this locality. Eldorado, Hoosier, Lovett's Best, Ohmer, Woodford and Topsy fruited here for the first time, hence a comparison of their yields this season gives the apparent rather than the positive relation of their productiveness.

Early Harvest. This variety is being recommended as valuable for New England but it was tested several years ago in the experiment plots and after five seasons' trial was discarded as too tender and too small to be of any value.

Eldorado. A vigorous growing variety that seems quite hardy and very productive. Fruit medium size ; good quality. Has not fruited enough to prove its value.

Hoosier. Fairly vigorous, hardy and very productive. Fruit large ; quality very good. A promising variety.

Ohmer. Vigorous ; although not much injured the past winter, it was badly killed back the previous year and is of doubtful hardiness. Fruit very large and handsome, but poor in quality.

Topsy. This variety winter-kills so badly that it can be of no value here.

Woodford. Not very vigorous or productive the past season, but quite hardy. Fruit large, of fine appearance and good quality.

Snyder, Taylor and Agawam are the standard varieties for this locality. Snyder is a profitable market variety under high cultivation.

Strawberries.

In the following table the results of the variety tests with strawberries are given in condensed form. In this test of varieties, many of the older ones that had proved worthless or of little value previous to 1896, were discarded, and many new ones added. The plots from which the records were taken were set the first week in May, 1895. Twenty-five plants of each variety were set eighteen inches apart. Sept. 11, a severe hail storm accompanied by a heavy fall of rain swept over the grounds, cutting the foliage badly and washing and covering many of the plants. This made the results less satisfactory than they otherwise would have been, but as they all received the same treatment, this probably did not affect their relative standing.

The fruit was carefully weighed when picked to determine the productiveness.

EXPLANATION of TABLE.

Size—l, large; m, medium; s, small. *Color*—s, scarlet; c, crimson; l, light; d, dark. *Form*—r, round; c, conical; ir, irregular; l, long. *Sex*—p, pistillate; b, bi-sexual. *Productiveness, Vigor and Quality*—10 is nearest perfection.

VARIETY.	Sex.	Vigor.	Date of blooming.	Date of ripening.	Date of first picking.	Date of last picking.	Productiveness.	Size.	Form.	Quality.	Firmness.	Color.
Accomack,	B	7.5	May 6	June 6	June 9	June 27	4.4	l	lc	8.5	f	dc
America,	B	5	" 10	" 6	" 19	" 19	2	m	rc	8.5	m	s
Anna Forest,	B	8.5	" 6	" 2	" 6	" 27	5.8	l	rc	8.5	s	lc
Aroma,	B	8	" 11	" 1	" 6	" 27	7.8	m	rc	8	s	bc
Arrow,	P	8	" 7	" 4	" 6	" 28	8.9	m	lc	8.5	m	c
Auburn,	P	8	" 9	May 30	" 6	" 26	8.1	m	lc	7.5	m	c
Australian Everbearing,	B	8	" 7	June 1	" 6	" 29	5.8	m	c	7.5	m	ls
Banquet,	B	7	" 7	" 4	" 13	" 29	5.4	l	lc	7.5	f	dc
Barton's Eclipse,	P	6	" 4	May 28	" 6	" 24	6.5	l	c	7	m	c
Beaver's No. 3,	B	7	" 14	June 6	" 11	" 77	6	l	ir	9	m	lc
Beede,	B	7	" 8	" 1	" 6	" 27	7.3	m	ir	7	m	s
Belle,	B	6.5	" 6	" 7	" 19	" 27	4.4	m	lc	8.5	f	dc
Belmont,	B	9	" 13	" 5	" 13	" 27	5	l	c	8.5	m	c
Beverly,	B	8.5	" 5	" 2	" 6	" 29	8.7	m	irc	8.5	f	c
Bisel,	P	8.5	" 6	" 5	" 6	" 27	9.1	l	c	7	m	lc
Boeckley,	P	9	" 7	" 4	" 9	" 27	8.5	m	c	7	m	ds
Bostonian,	B	9.5	" 12	" 5	" 10	" 29	7.9	s	c	7.5	m	bs
Boynton,	P	6.5	" 4	May 26	" 6	" 27	5.1	s	c	7.5	m	lc
Brandywine,	B	8.5	" 6	June 4	" 6	" 27	6.9	l	ir	8.5	f	dc
Breeze's Seedling	B	7	" 5	May 31	" 9	" 27	5.1	m	rc	8.5	f	s
Briggs' Seedling 1	P	7	" 5	" 31	" 9	" 27	4.1	m	rc	8	f	c
Briggs' Seedling 2	B	7.5	" 4	" 30	" 6	" 24	4.2	m	rc	8	m	c
Bubach, No. 5,	P	8	" 4	" 29	" 6	" 24	6.2	m	ir	8	f	c
Chairs,	B	7	" 4	" 29	" 6	" 27	7.3	l	r	8.5	m	c
Charlie,	P	8	" 4	" 29	" 6	" 27	8.2	s	r	6.5	s	s
Charles Downing	B	7.5	" 7	" 31	" 6	" 27	5.5	m	ir	9	f	c
Clark's Seedling 1	P	7	" 4	" 29	" 6	" 24	4.7	m	c	8.5	s	dc
Clark's Seedling 2	B	8	" 5	June 2	" 9	" 27	9.3	m	c	8	s	ds
Clark's Seedling 3	B	7	" 4	May 30	" 10	" 27	7.3	l	rc	8.5	f	dc
Clark's Seedling 4	B	7.5	" 4	" 29	" 6	" 29	7.4	m	ir	7.5	m	dc
Columbian,	B	9	" 4	June 1	" 9	" 27	7.2	m	r	7	m	s
Crawford's No. 51	B	8	" 7	" 1	" 6	" 29	9	l	ir	8	f	dc
Crescent,	P	7	" 4	May 28	" 6	" 27	8	s	c	7	f	s
Cumberland,	B	8.5	" 4	" 31	" 6	" 29	8.1	l	rc	9	ms	ls
Cutter's Seedling,	B	7.5	" 5	" 30	" 6	" 29	6.9	s	lc	9	f	ls
Cyclone,	B	5	" 7	" 29	" 6	" 27	5.9	m	lc	7	m	c
Davis No. 2.	B	8	" 13	June 5	" 10	" 29	5	vl	rir	8.5	m	c
Dayton,	B	7	" 6	May 29	" 6	" 29	5.5	m	lc	7.5	m	s
Dew,	B	8.5	" 12	June 5	" 15	" 29	4.8	vl	ir	7.5	m	dc
Dutton,	B	7.5	" 11	" 5	" 9	" 27	4.3	m	c	8	s	c
Edgar Queen,	P	8	" 10	" 5	" 9	" 29	7	l	ir	8	s	c
Edith,	P	7.5	" 14	" 11	" 19	" 29	4.2	vl	ir	8	s	c
Edw.'s Favorite,	B	7.5	" 4	" 1	" 19	" 26	2	m	lc	8	s	c
Eleanor,	B	8	" 7	May 31	" 6	" 29	5.4	m	rc	8.5	m	c
Enhance,	B	8	" 5	" 31	" 6	" 29	8.1	l	ir	8	m	dc
Enormous,	P	8.5	" 12	June 4	" 9	" 29	7.8	l	r	7.5	m	c
Epping,	P	8.5	" 8	" 1	" 6	" 27	4.5	m	rc	8	s	s
E. P. Roe,	B	8	" 4	" 5	" 10	" 29	6.4	m	ir	6.5	s	c
Equinox,	B	6	" 9	" 4	" 9	" 29	5	m	ir	7.5	s	s
Excelsior,	B	7.5	" 9	May 31	" 6	" 27	5.5	m	lc	8	m	s
Felton,	B	7.5	" 9	June 5	" 9	" 29	5.2	l	lc	8.5	m	dc
Fountain,	B	8	" 12	May 29	" 6	" 29	6.5	m	c	8	m	dc

VARIETY.	Sex.	Vigor.	Date of blooming.	Date of ripening.	Date of first picking.	Date of last picking.	Productiveness.	Size.	Form.	Quality.	Firmness.	Color.
Fremont,	B	7	May 9	June 7	June 9	June 29	6.6	m	c	8.5	f	c
Gandy,	B	7	“ 7	“ 1	“ 6	“ 29	5.3	m	c	8.5	f	s
Gandy Belle,	B	8.5	“ 11	“ 3	“ 9	“ 29	9.7	l	c	8	f	c
Gen. Putnam,	P	8.5	“ 2	May 31	“ 6	“ 29	9.3	l	r	8	m	lc
Gillespie,	B	8	“ 7	June 3	“ 9	“ 27	6	l	lc	8.5	s	lc
Glendale,	B	8	“ 6	“ 4	“ 9	“ 29	2	m	ir	8	m	dc
Glen Mary,	B	8.5	“ 9	May 30	“ 6	“ 29	9	vl	irc	8	m	dc
Golden Defiance,	P	8.5	“ 8	June 5	“ 10	“ 29	6 6	m	c	8	m	c
Gov. Hoard,	B	8	“ 6	“ 3	“ 6	“ 27	5 5	l	ir	8.5	f	dc
Greenville,	P	8	“ 9	“ 5	“ 9	“ 27	7.5	l	c	8.5	m	c
Hall,	B	8	“ 10	“ 5	“ 10	“ 29	5 7	l	lc	8	m	c
Haverland,	P	8.5	“ 2	May 28	“ 6	“ 27	9 3	l	.c	8	m	s
Howard's No. 1,	P	8.5	“ 4	June 3	“ 6	“ 27	6.2	m	lc	9 5	f	c
“ No. 14,	P	9.5	“ 5	May 29	“ 6	“ 29	9	l	lc	9.5	m	c
“ No 23,	P	7.5	“ 4	“ 31	“ 6	“ 29	8 3	m	lc	8	m	dc
“ No. 28,	P	8	“ 7	June 5	“ 6	“ 29	6.6	m	rc	8.5	f	e
“ No. 30½,	P	8 5	“ 8	“ 5	“ 10	“ 29	7.1	l	l	8	m	lc
“ No. 36,	P	8	“ 7	May 30	“ 6	“ 29	9.1	m	lc	8	m	c
“ No. 41,	P	8 5	“ 6	June 4	“ 6	“ 29	8.1	l	ir	8.5	m	dc
“ No. 501,	B	8.5	“ 6	“ 5	“ 9	“ 29	7	m	ir	8.5	m	e
“ No. 601,	B	7	“ 4	May 30	“ 6	“ 27	9 2	m	rc	8	f	dc
“ No. 605,	B	6.5	“ 4	“ 31	“ 6	“ 27	4.7	m	rc	8	f	c
Huntsman,	B	7	“ 5	June 2	“ 6	“ 27	6.2	m	rc	7.5	m	c
H. W. Beecher,	B	9	“ 10	“ 5	“ 9	“ 24	5 3	l	ir	8	s	c
Idaho,	B	6	“ 6	May 31	“ 6	“ 29	7 4	s	r	8	m	dc
Iowa Beauty,	B	6 5	“ 9	“ 30	“ 6	“ 29	8.4	m	rc	8.5	s	s
Ivanhoe,	B	7.5	“ 12	“ 31	“ 6	“ 29	7.4	s	r	8	m	lc
Jackson & Perkins	P	8.5	“ 13	June 4	“ 6	“ 29	6.5	l	lc	8	m	e
Jay Gould,	P	8	“ 10	“ 4	“ 6	“ 29	6.8	m	lc	8	m	c
Jucunda,	B	8	“ 11	“ 5	“ 9	“ 29	6.8	m	rc	9	m	dc
Judsonia,	B	8	“ 11	May 30	“ 9	“ 29	7.5	m	ir	8	m	c
Katie,	P	7	“ 12	June 4	“ 9	“ 29	6.3	m	r	7.5	s	c
Klickita,	P	8.5	“ 7	“ 5	“ 6	“ 29	6.8	m	rc	7.5	m	s
Laxton's Captain,	P	5	“ 8	“ 10	“ 19	“ 27	2	m	r	8	m	c
“ Com'ander	B	6	“ 6	May 31	“ 6	“ 27	3.9	m	r	8	m	c
Leader,	B	8	“ 5	“ 30	“ 6	“ 29	6.1	l	rc	8 5	f	dc
Loudon,	B	7.5	“ 8	June 2	“ 6	“ 27	4	m	c	8	f	dc
Lovett's Early,	B	8	“ 9	“ 1	“ 6	“ 29	8.4	m	rc	8	f	c
Lucy,	B	8.5	“ 4	“ 1	“ 9	“ 29	8.1	l	rc	8	s	c
Luther,	B	7.5	“ 4	May 28	“ 6	“ 29	6.8	m	l	9 5	m	c
Margaret,	B	7	“ 11	June 5	“ 13	“ 29	3.6	m	c	8.5	m	ds
Marshall,	B	9	“ 6	May 30	“ 6	“ 29	6.8	vl	rc	9	f	dc
Marston,	P	7	“ 4	“ 29	“ 6	“ 29	9.2	m	c	8	m	s
Mary,	P	9	“ 12	June 5	“ 10	“ 29	9.1	l	ir	8	m	c
Maxwell,	B	6	“ 4	May 26	“ 6	“ 29	6.8	s	lc	9	f	s
Meek's Early,	B	7.5	“ 4	“ 30	“ 6	“ 19	3.6	m	r	8.5	m	c
Mineola,	B	7	“ 9	June 6	“ 9	“ 24	3.1	m	r	9	m	ds
Miner's Prolific,	B	8	“ 10	“ 4	“ 9	“ 29	5.4	l	c	8.5	f	c
Moore,	B	7.5	“ 5	May 29	“ 6	“ 24	5	m	r	8	m	s
Mrs. Cleveland,	P	7	“ 4	“ 30	“ 6	“ 29	4.5	m	rc	8 5	m	c
Mt. Vernon,	B	7.5	“ 4	June 4	“ 11	“ 24	3	m	r	7.5	m	c
Muskingum,	B	7	“ 11	“ 5	“ 14	“ 24	2	l	r	8	m	dc
Mystic,	B	9	“ 12	“ 5	“ 19	“ 24	2	l	r	9	m	dc

VARIETY.	Sex.	Vigor.	Date of blooming.	Date of ripening.	Date of first picking.	Date of last picking.	Productiveness.	Size.	Form.	Quality.	Firmness.	Color.
Nehrings Gem,	P	8.5	May 12	June 4	June 9	June 27	5.8	l	r	8.5	f	c
Norther's Seedl'g,	B	8	" 8	" 1	" 6	" 24	3.3	l	ir	8.5	m	c
Ohio Centennial,	B	8	" 7	May 30	" 6	" 27	6	l	ir	8	m	c
Oliver,	B	8	" 11	June 4	" 13	" 29	4.3	l	ir	8.5	m	c
Omega,	P	8	" 4	May 30	" 6	" 27	6.1	m	ir	8.5	f	ds
Ona,	P	6	" 9	June 1	" 6	" 27	3.8	m	rc	8.5	m	c
Orange County,	P	7	" 9	" 4	" 6	" 22	5.2	m	r	8.5	s	ls
Oregon,	B	7	" 9	" 5	" 9	" 22	2	m	c	7.5	m	c
Otsego,	P	8	" 12	" 3	" 6	" 29	8.2	s	r	7.5	s	c
Our Choice,	P	8.5	" 9	" 5	" 6	" 27	7	s	r	8.5	m	ds
Pacific,	P	7.5	" 12	" 3	" 6	" 27	8.6	l	ir	8	f	dc
Paris King,	B	8	" 8	" 1	" 6	" 29	6.4	l	rc	7.5	m	s
Parker Earle,	B	8.5	" 11	" 1	" 9	" 29	10	l	lc	9	f	c
Perpetual,	P	6	" 4	May 28	" 6	" 27	5.7	s	c	8 5	m	dc
Pioneer,	B	7	" 6	" 31	" 6	" 29	4.5	m	r	8 5	m	s
Pomona,	B	8	" 8	" 30	" 6	" 29	4.8	m	r	8.5	m	c
Princess,	P	6.5	" 8	" 31	" 6	" 29	5.4	m	lc	9	m	c
Princeton Chief,	P	8.5	" 13	June 6	" 11	" 24	6.8	m	ir	8	m	dc
Regina,	P	7.5	" 14	" 5	" 18	" 27	3.6	m	rc	7.5	m	dc
Richmond,	B	6	" 9	May 30	" 6	" 27	4.1	l	ir	8	f	c
Rio,	B	7	" 4	" 28	" 6	" 27	5 5	m	rc	8.5	f	s
Robinson,	B	9	" 9	" 30	" 9	" 29	7 5	m	rc	8	m	s
Sam,	B	6	" 8	June 2	" 6	" 29	6.3	m	irc	9.5	f	c
Seedling B.,	P	8	" 3	May 30	" 6	" 27	7.7	l	rc	9	m	c
" 24,	B	6	" 8	" 31	" 6	" 29	4 8	vl	c	7.5	s	dc
" 45,	B	7	" 9	June 4	" 9	" 27	4.1	m	c	9	f	dc
" 48,	B	8	" 8	May 31	" 6	" 27	5 8	vl	c	7.5	s	ls
Sharpless,	B	8	" 9	June 4	" 10	" 23	3.8	l	ir	9	m	c
Shaw,	B	7	" 12	" 4	" 9	" 27	4	m	r	7.5	m	dc
Sherman,	B	5	" 10	" 5	" 18	" 23	2	l	rc	9	s	c
Shuckless,	B	7	" 9	" 5	" 6	" 27	5.8	m	c	8.5	m	lc
Splendid,	B	8	" 10	" 4	" 6	" 27	8	l	r	8.5	m	s
Smith's Seedling,	B	7	" 11	" 5	" 9	" 27	6	l	ir	7.5	s	dc
Southard,	B	6	" 7	" 3	" 6	" 27	6.8	m	ir	8.5	s	dc
Standard,	B	6	" 9	" 1	" 6	" 27	7.2	l	c	8 5	m	c
Stone's Seedling,	P	8	" 12	May 31	" 6	" 27	6.3	m	rc	8	s	dc
Sunnyside,	P	7	" 11	June 5	" 6	" 27	6.7	m	c	8.5	m	c
Tennessee Prolific	B	8	" 4	" 3	" 6	" 27	6	l	irc	8	f	c
Thompson,	B	8	" 3	May 31	" 6	" 27	6.8	l	ir	9	f	c
Thompson's No. 66	P	7	" 6	" 30	" 6	" 27	6.1	m	lc	7.5	m	dc
Timbrell,	P	8	" 9	June 8	" 9	" 27	4.1	l	c	9.5	f	dc
Townsend,	P	8	" 9	" 4	" 6	" 24	5.6	m	c	8.5	m	dc
Tinker's No 2,	P	9	" 8	" 4	" 6	" 27	7.6	s	c	7	m	c
Tubbs,	B	8	" 10	" 6	" 9	" 23	3.4	m	rc	8.5	f	dc
Van Dieman,	B	8	" 3	May 28	" 6	" 27	6.8	l	c	8.5	m	dc
Victor Hugo,	B	8	" 9	June 3	" 6	" 27	4.1	l	r	8.5	m	s
Warfield,	P	7.5	" 6	May 29	" 6	" 27	9.2	m	rc	8	f	dc
Wentzell,	B	7	" 10	June 2	" 6	" 22	5.9	s	rc	8.5	s	c
Williams,	B	7	" 13	" 3	" 6	" 27	4.7	l	c	8.5	m	c
Wilson,	B	5	" 8	" 1	" 9	" 27	2 5	m	rc	8.5	m	c
West Lawn,	P	8	" 11	" 1	" 6	" 27	5.9	m	c	8	m	c
Wolverton,	B	7	" 13	" 5	" 10	" 24	2.6	m	rc	8 5	f	dc
Wonder,	P	8	" 12	" 5	" 11	" 27	4.1	l	c	9.5	f	dc

Supplementary to the table we give below a few notes on some varieties of recent introduction and on a few older varieties requiring special mention. Descriptions of the other varieties will be found in former bulletins of this station.

Australian Everbearing, Breeze's Seedling, Briggs' Seedling, Eleanor, Fountain, Hall, Ivanhoe, Margaret, Mineola and Victor Hugo fruited for the first time on the station grounds, and failed to give much promise of value. They will require further testing before a positive report of their value can be given.

Arrow. Plant vigorous, setting abundant runners; foliage very free from blight. Fruit medium, even in size, bright crimson, moderately firm and of good quality. One of the most productive of the new varieties.

Banquet. A moderate grower, somewhat subject to blight. Fruit medium to large, rich dark crimson, quite firm and of fair quality. This is a very handsome berry, but did not appear to be productive enough to be profitable for market, and did not possess the high quality that has been accorded it. Needs further trial.

Beverly. A very valuable variety for market or home use. It appears to be identical with the old Miner's Prolific.

Bisel. Moderately vigorous; foliage showed considerable blight. Very productive, large conical berries, of medium firmness, but only fair quality. A promising variety, worthy of a trial.

Boeckley. Plant very vigorous and productive, setting many runners. Fruit of medium size, bright scarlet color and rather inferior quality. Its fine foliage, freedom from blight and great productiveness make it worthy of trial.

Bostonian. A very vigorous grower, but subject to blight; runners very abundant; leaf stalks long and slender; fruit stalks long but upright. Blooms profusely, but berries do not set well, and it has proved only fairly productive. Berries small to medium; regular conical; bright scarlet; fair quality. A promising late variety.

Brandywine. A vigorous grower, setting many runners. Fruit conical, sometimes irregular in form, rich dark crimson, quite firm and of good quality. A very large, attractive, productive berry, valuable for market or amateur growers.

Columbian. Plant very vigorous, quite free from blight. Fruit medium size, round, scarlet, medium firm and fair quality. It did not prove as productive as its fine growth promised and is of doubtful value.

Davis No. 2, *Edward and Edith* are all very late berries of enormous size, but are not sufficiently productive to be profitable for market.

Crawford's No. 51. Vigorous and quite free from blight. Fruit very large, inclined to be irregular; firm, dark crimson, fair quality. Its large size, firm texture, and attractive appearance would make it a profitable market variety if always as productive as here the past season. It is often reported unproductive.

Enormous. Moderately vigorous grower, quite free from blight; runners abundant. Fruit very large, quite regular and uniform for so large a berry; medium texture; bright crimson color; fair quality. It proved only moderately productive the past season, but it has many good qualities and is worthy of a trial.

Gandy Belle. Plant, a low strong grower; runners abundant; foliage liable to burn, but resists blight fairly well. Fruit large, conical, texture quite firm, color bright crimson, quality good. A very attractive berry and one of the most productive on the grounds.

Glen Mary. Plant, a good grower, runners abundant. Fruit very large; form irregular, conical; dark crimson color; good quality. Very productive and one of the most promising of the newer varieties.

Haverland. Still unsurpassed for amount of fruit and duration of yield.

Howard's Seedling No. 14. Seedling of Haverland, which it much resembles. Its foliage is more vigorous, fruit stalks more upright, color darker and quality far superior to the Haverland. It is very productive, but not quite equal to its parent.

Lucy. Plant vigorous, foliage good. Fruit large, regular, round, conical in form, texture rather soft, quality good. Productive and promising.

Luther. A very early berry of large size and finest quality. If it can be grown so as to be more productive it will prove a very valuable variety.

Marshall. From the results obtained in the plots and the field, we come to the conclusion that the Marshall cannot be profitably produced for market on the college grounds by the ordinary methods of cultivation. It is valuable for the amateur, and possibly for the skillful cultivator, to supply a fancy trade.

Marston. Plant vigorous, foliage free from blight, leaf stalk long and slender. Fruit medium size, form conical, texture medium, color scarlet. It ripened with the earliest and stood third for productiveness. A very promising early berry.

Paris King. Moderately vigorous, foliage blighted slightly. Fruit large and very attractive in appearance, quality fair. It is a free bloomer bearing abundant pollen and is a good pollenizer.

Parker Earle. Stands at the head of the station list for productiveness, twenty-five plants bearing sixty-nine ounces more than any other variety in the plots. When given a rich heavy soil and an abundant supply of water it is very productive, but unless these requirements are fulfilled it usually proves a failure.

Rio. A fairly vigorous grower, foliage blights little. Fruit small to large, round, conical in form, firm and of good quality. The first berries to ripen are large, the later ones are smaller. Was not productive this season. It has been productive in other places and has many good qualities for an early berry.

Splendid. A large, round berry of good quality and very fine appearance. Foliage strong and healthy. Promising.

Wonder. Evidently identical with the Timbrell. It ripens a little more evenly, but not enough to warrant its introduction as a new variety.

Based upon the results of the past season's test, the following varieties are to be recommended:

Ten Best Standard Varieties, Beverly; Brandywine; Bubach; Enhance; Golden Defiance; Greenville; Haverland; Leader; Lovett; Parker Earle.

Ten Most Promising Varieties of those less generally grown, Arrow; Glen Mary; Gandy Belle; Howard's No. 14; Luther; Marston; Pacific; Princess; Rio; Splendid.

Field Strawberries.

Of the thirty varieties of strawberries that were given a test under ordinary field culture, the following, named in order of their yield were most productive: Haverland, Greenville, Eureka, Lovett's Early, Miner's Prolific, Pacific, Our Choice and Mrs. Cleveland.

Haverland and Lovett's Early produced more than any other varieties previous to June 11 and Eureka and Golden Defiance gave the largest yields after June 25.

New Types Of Small Fruits.

The persistent advertisement given to the new types of Raspberries and Blackberries makes it desirable that a report should be made of the behavior of such as are growing on the station grounds. Nearly every one of these creations are more or less tender and little can be expected from them except possibly from crosses that may be made with our hardy cultivated varieties. The plants reported upon were planted in the spring of 1895.

Golden Mayberry. Not very vigorous. Appears quite hardy. Stocky and compact in growth. No fruit produced.

Logan Berry. Wintered perfectly when partly covered with soil. Unprotected canes were badly injured. A few blossoms opened, but no fruit was matured.

Salmon Berry. Winter-killed to the ground. Is not vigorous. Did not fruit.

Strawberry Raspberry. Wintered in the house. Set quite a number of berries but they failed to mature. Probably of little value.

Japanese Wineberry. An interesting novelty but of little value.

Dwarf June Berry. This plant makes a low growth and produced considerable fruit, but its value in the market is doubtful.

Dwarf Rocky Mountain Cherry. The trees of this fruit are making a rapid growth, but as yet have borne no fruit. With so many more valuable fruits now grown it can hardly be expected that this will become an important product in Massachusetts.

THINNING FRUITS.

The past season has emphasized the necessity of reducing the number of specimens of fruit on heavily loaded trees in order to save the strength of the tree and improve the size and quality of the fruit. With the apple crop this necessity is more marked than with any other fruit. Nearly all of our fruit trees possess the characteristic of producing one year so large a crop that they cannot mature a crop the next season, requiring sometimes several years to recover from the exhaustion.

On the station grounds it has been the practice for many years to thin all the kinds of fruit more or less and we present in this bulletin a few illustrations of the beneficial and profitable results.

No. 1. Two full sized Gravensteins of uniform vigor and productiveness were selected. One was thinned July 1st, the other being reserved for a check. The fruit set in great abundance and at the time of thinning, the two trees appeared equally productive. It should be said that if the tree had been thinned at least two weeks earlier, better results might have followed. As the fruit approached maturity a decided difference was noticed in favor of the thinned tree, but unfortunately for the experiment, a large per cent of the fruit dropped prematurely, as many Gravensteins did in other sections of the State. The results therefore were far from satisfactory; nevertheless they indicate what may be expected when conditions are more favorable.

GRAVENSTEIN.	Firsts.	Seconds.	Windfalls.	Market Value.	Gain.
Thinned Tree,	7 bu.	1 bu.	9½ bu.	4.45	2.33
Check,	2½ bu.	2½ bu.	10¼ bu.	2.12	
Cost of Thinning,					.48
					$1.85

Deducting from this 48 cents, the actual cost of thinning, we have a net gain of $1.85*

No. 2. Two trees of the Russian apple Tetofsky were selected, one being thinned July 1st, the other remaining for comparison. Both were of equal size and productiveness. At the date of ripening, July 29, a remarkable difference in the size and beauty of the fruit was noticeable.

TETOFSKY.	Firsts.	Seconds.	Windfalls.	Market Value.	Gain.
Thinned Tree,	2 bu.	½ bu.	1 bu.	1.32	1.20
Check,		½ bu.	3 bu.	.12	
Cost of Thinning,					.35
					$ .85

Deducting 35 cents, the cost of thinning we have a net gain of 85 cents.*

The unusually large per cent of windfalls may be attributed to the peculiar distribution of the fruit in this variety. The apples have very short stems and are borne in clusters of from three to eight so that, as growth increases, a large number are crowded off and even those remaining have not sufficient room for full development. It is evident that thinning is of special advantage to this

*Allowing 60 cents per bushel for firsts, and 25 cents for seconds.

variety, the more so since it gives promise of becoming a valuable market apple, being of excellent quality.

No. 3. A tree each of Guei and Victoria plums was divided into approximately equal halves, one half of each being thinned July 1st, the other remaining as a check. The fruit of the Guei ripened and was picked Aug. 22, the Victoria Aug. 24.

The results are shown in the following table:

VARIETY.	Marketable Plums.	Value.	Gain.	Per cent Fruit Rotted.
Guei—Thinned,	9 qts.	.81	.32	28
Guei—Check,	5½ qts.	.49		42
Victoria—Thinned,	16 qts.	1.44	.59	20
Victoria—Check,	9½ qts.	.85	.91	46
Cost of thinning two half trees,			.30	
			.61	

Allowing 12 cents for thinning the Guei and 18 cents for the Victoria we have a net gain of 20 and 41 cents respectively for each half tree.

A distinct advantage gained by thinning is the appreciable decrease in the ravages of fungous diseases, and to a small extent, of insect pests. This is especially noticeable in the case of Monilia or brown fruit rot which often ruins the peach or plum crop in wet seasons, while the specimens of fruit attacked by the curculio were largely removed in thinning. The per cent of fruit affected with Monilia was determined by count at time of picking and may therefore be taken as a fair estimate of the actual results.

EXPERIMENTS WITH CATERPILLAR LIME.

The claims made by the introducers of the two substances known as Raupenleim and Dendrolene are that while they are soft they will catch all insects that may come in contact with the coating; that borers or other insects will not lay their eggs on the trunks covered with them and that if put on after these insects have entered they cannot escape; that they will not injure the most delicate trees to which they are applied

It will be seen that the value of this material must depend largely upon the length of time it retains viscidity. To determine this point, six young trees each, of apple, pear, plum and cherry were treated July 16 as follows: No. 1, Raupenleim $\frac{1}{16}$ inch thick. No.

2, Raupenleim $\frac{1}{8}$ inch thick. No. 3, Raupenleim $\frac{1}{4}$ inch thick. The other three were treated with Dendrolene in like manner. On those trees receiving an application of $\frac{1}{4}$ and $\frac{1}{8}$ inch the band was 18 inches wide; when applied $\frac{1}{16}$ inch thick the whole tree was covered except the leaves and growing shoots. Records were taken once a week throughout the summer. A synopsis of results follows:

Raupenleim No. 1., remained perfectly soft for four weeks, after which it hardened and was useless.

Dendrolene No. 1., dried in very quickly and was of little value at the end of three weeks.

Raupenleim No. 2. Good for four weeks, then hardened.

Dendrolene No. 2. Good for four weeks, by which time it had lost its viscid character and resembled grease with a slight crust. It melted and ran badly.

Raupenleim No. 3. Good for ten weeks. Has a tendency to crack and peel off in large flakes, especially on the pear and apple.

Dendrolene No. 3. Good for eight weeks. Loses most of its viscidity at the end of five weeks, melts and runs badly.

The trees treated over the entire surface were all injured; some of them dying within three weeks after application. Where applied to older trees no injury has thus far been noticed, another season being necessary to settle this point. It is only necessary for us to suggest that its effectiveness as an insecticide has in no way been proven and that it is unsafe to apply these substances to young trees.

VARIETY TESTS OF VEGETABLE SEEDS.

In the spring of 1896 a series of experiments was begun in order to determine the vitality and purity of the garden seeds which are being placed upon the market. For this purpose, seeds of 14 kinds of vegetables were purchased from seven prominent seedsmen. Three or four varieties each of the most commonly grown vegetables and as far as possible the same varieties from each seedsman were selected.

In order to determine their vitality two tests were made.

In the first, 50 seeds of each lot were placed in a seed-tester.

In the second, 50 seeds were placed upon cheese cloth covered with same and laid upon moist sand and all covered with boards which were slightly raised to give free circulation of air.

The results of both tests were quite uniform and the average of the two is given in the following tables:

BEETS.	Time of first germination.	Time of last germination.	Time in which 50% germinated.	Per cent of seeds germinated.
Early Red Bassano,				
Gregory,	4	19	5½	75
Ferry,	5	20	8	80
Dreer,	4	21	7½	77
Henderson,	4	12	6	66
Breck,	5	13	7	79
Rawson,	4	20	6½	85
Farquhar,	4	20	6½	82
Crosby's Early Egyptian,				
Gregory,	4	12	5½	86
Ferry,	5	18	7	70
Dreer,	4	13	5½	76
Henderson,	4	14	7	50
Breck,	4	20	7½	68
Rawson,	4	16	7½	85
Farquhar,	4	15	6½	75
Dewings Early Blood Turnip,				
Gregory,	4	21	7½	86
Ferry,	4	20	7	86
Dreer,	4	13	7	90
Henderson,	6	18	7½	57
Breck,	5	19	7	79
Rawson,	4	16	6½	92
Farquhar,	4	19	7	91
Edmand's Blood Turnip,				
Gregory,	4	20	8	77
Ferry,	4	19	7	87
Dreer,	4	12	6½	83
Henderson,	4	13	7	76
Breck,	4	19	8	77
Rawson,	4	19	6½	69
Farquhar,	5	20	8½	64
CABBAGES.				
Henderson's Early,				
Gregory,	3	19	4	81
Ferry,	3	11	5	97
Dreer,	3	8	3½	91
Henderson,	3	8	4½	81
Breck,	3	11	3½	91
Rawson,	3	8	3½	96
Farquhar,	3	8	3½	97
All Seasons,				
Gregory,	3	11	4	71
Ferry,	3	12	3½	90
Dreer,	3	9	5	95
Henderson,	4	14	6½	49
Breck,	3	13	3½	90
Rawson,	3	9	3½	89
Farquhar,	3	11	4	71

CABBAGES.	Time of first germination.	Time of last germination.	Time in which 50% germinated.	Per cent of seeds germinated.
Foltlers Brunswick,				
Gregory,	3	14	5	81
Dreer,	3	12	3½	100
Henderson,	3	10	4	98
Breck,	3	9	3½	93
Rawson,	3	9	4	86
Farquhar,	3	8	3½	94
Flat Brunswick,				
Ferry,	3	8	4	94
Early Jersey Wakefield,				
Gregory,	4	15	5	89
Ferry	3	8	3½	93
Dreer,	3	8	4	83
Henderson,	3	14	3½	80
Breck,	3	10	3½	92
Rawson,	3	10	4	94
Farquhar,	3	11	3½	87
CAULIFLOWER.				
Early Dwarf Erfert.				
Gregory,	3	9	4	81
Ferry,	3	12	4	88
Dreer,	3	10	4½	72
Henderson,	3	13	4½	77
Breck,	3	14	3½	77
Rawson,	3	12	4	90
Farquar,	3	10	4½	83
Early Paris,				
Gregory,	3	8	4	82
Ferry,	3	10	4	86
Dreer,	3	16	4½	95
Henderson,	3	13	3½	90
Breck,	3	15	4	86
Rawson.	3	11	4	93
Farquhar,	3	15	4	71
Early Snowball.				
Ferry,	3	14	5	77
Dreer,	3	16	4	80
Henderson,	3	14	4	84
Breck,	3	14	4	72
Rawson,	3	14	4	76
Farquhar,	3	9	3½	77
CELERY.				
White Plume,				
Gregory,	8	17	13½	68
Ferry,	9	18	11	88
Dreer,	6	16	11	61
Henderson,	7	20	11½	65
Breck,	7	16	11½	32
Rawson,	7	22	13	68
Farquhar,	6	18	11	80

CELERY. (Continued.)	Time of first germination.	Time of last germination.	Time in which 50% germinated.	Per cent of seeds germinated.
Giant Pascal,				
Gregory,	7	16	13	75
Ferry,	6	19	10	81
Dreer,	7	19	10½	75
Henderson,	7	22	12	75
Breck,	7	21	11½	78
Rawson,	7	20	12½	96
Farquhar,	8	18	11	94
Boston Market,				
Gregory,	7	13	11½	65
Ferry,	6	14	11	69
Dreer,	8	17	12½	44
Henderson,	7	16	12	69
Breck,	7	18	11½	70
Rawson,	6	21	10	92
Farquhar,	6	17	10½	80
Paris Golden,				
Gregory,	7	15	12½	64
Rawson,	7	22	12	64
Golden Yellow,				
Ferry,	6	21	11½	74
Dreer,	7	17	11	45
Henderson,	8	22	18½	51
Breck,	7	22	13½	64
Farquhar,	7	17	16½	65
CUCUMBERS.				
Talby's Hybrid,				
Gregory,	2	19	6	92
Ferry,	6	16	5	96
Dreer,	2	22	4½	98
Henderson,	3	20	8	88
Breck.	2	24	4	92
Rawson.	2	18	6½	80
Farquhar,	2	11	4½	83
Improved White Spine,				
Gregory,	2	18	4½	99
Ferry,	2	10	5	95
Dreer,	2	15	5	80
Henderson,	2	15	4½	95
Breck,	2	15	4½	89
Rawson,	2	11	5	95
Farquhar,	2	14	6	98
Long Green,				
Gregory,	3	11	7	71
Ferry,	2	10	4½	93
Dreer,	2	8	4½	100
Henderson,	2	8	5	88
Breck,	2	10	5	94
Rawson,	2	8	4½	100
Farquhar,	2	16	6½	55

CUCUMBERS. (Continued.)	Time of first germination.	Time of last germination.	Time in which fifty per cent germinated.	Per cent of seeds germinated.
Early Cluster,				
Gregory,	2	13	6	80
Ferry,	2	10	4½	98
Dreer,	2	13	5	91
Henderson,	2	12	4½	93
Breck,	2	10	4½	90
Rawson,	2	7	4½	86
Farquhar,	2	16	6½	74
LETTUCE.				
Hanson,				
Gregory,	2	6	2	100
Ferry,	2	4	2½	100
Dreer,	2	4	2½	100
Henderson,	2	4	2½	100
Breck,	2	3	2½	100
Rawson,	2	3	2½	100
Farquhar,	2	5	2	100
Boston Curled,				
Gregory,	2	9	2½	100
Henderson,	2	6	2½	100
Breck,	2	11	2½	100
Rawson,	2	9	2½	100
Farquhar,	2	4	2½	100
Black Seeded Tennis Ball,				
Gregory,	3	14	5½	78
Dreer,	2	6	3	99
Henderson,	2	3	2	100
Breck,	2	8	2½	100
Rawson,	2	5	2	100
Farquhar,	2	3	2	99
White Seeded Tennis Ball,				
Gregory,	2	7	3	98
Rawson,	2	4	3	100
Farquhar.	2	6	2	100
Early Tennis Ball,				
Ferry,	2	6	5½	87
Salamander,				
Dreer,	2	10	3	99
Boston Market,				
Dreer,	2	4	2	100
Henderson,	2	10	2½	100
Breck,	2	5	2½	100
MELONS.				
Hackensack,				
Gregory,	3	21	12	91
Ferry,	3	20	12	86
Dreer,	3	20	11½	90

MELONS. (Continued.)	Time of first germination.	Time of last germination.	Time in which fifty per cent germinated.	Per cent of seeds germinated.
Hackensack (continued),				
Henderson,	3	22	10½	90
Breck,	5	24	8½	74
Rawson,	5	25	11	85
Farquhar,	3	16	8½	96
Cascaba,				
Gregory,	6	26	15½	90
Ferry,	6	26	13	78
Dreer,	3	14	5	96
Henderson,	7	24	16½	66
Breck,	5	24	20½	70
Rawson,	6	14	15	38
Farquhar,	3	22	10	74
Early Nutmeg,				
Gregory,	6	23	13	93
Christiana,				
Gregory,	4	21	11	89
Henderson,	3	26	11	90
Breck,	3	24	11	76
Rawson,	7	21	15½	22
Farquhar,	3	20	9	71
Montreal,				
Ferry,	5	26	11	68
Dreer,	3	19	6	92
Henderson,	3	26	10	79
Breck,	3	22	9½	91
Rawson,	4	21	9½	90
Farquhar,	8	26	14	96
ONIONS.				
Early Round Yellow Danvers,				
Gregory,	3	10	6½	91
Giant Rocca,				
Gregory,	3	19	6½	76
Ferry,	4	18	7½	82
Dreer,	4	15	7½	84
Henderson,	3	15	9	77
Breck,	4	18	9	81
Rawson,	4	18	9½	72
Farquhar,	4	18	11	66
Large Red Weathersfield,				
Gregory,	3	7	4½	98
Ferry,	3	10	5½	94
Dreer,	3	16	7	73
Henderson,	3	15	6	79
Breck,	3	18	9½	77
Rawson,	3	15	7½	64
Farquhar,	3	18	7½	57

ONIONS. (Continued.)	Time of first germination.	Time of last germination.	Time in which fifty per cent germinated.	Per cent of seeds germinated.
White Portugal,				
Gregory,	3	20	6½	89
Ferry,	3	11	6	84
Dreer,	3	20	6	84
Henderson,	3	11	6	79
Breck,	3	20	7	86
Rawson,	3	16	6	94
Farquhar,	3	12	5	60
Yellow Globe Danvers,				
Ferry,	3	20	5½	90
Henderson,	3	11	6	95
Breck,	3	18	5½	79
Rawson,	4	12	8	64
Farquhar,	3	20	6½	87
PARSNIPS.				
Large Dutch,				
Gregory,	8	16	11	71
Abbots Hollow Crowned,				
Gregory,	8	18	11	74
Rawson,	8	18	13	86
Guernsey,				
Ferry,	6	21	9½	88
Henderson,	8	20	11	80
Breck,	8	22	11	93
Farquhar,	9	20	12½	67
Long White Dutch,				
Ferry.	7	20	8	74
Student,				
Dreer,	9	16	13	74
Henderson,	9	17	10½	77
Breck,	8	25	10½	76
Farquhar,	8	20	12	61
Large Sugar,				
Dreer,	9	23	12	56
Long Smooth, Dreer,	9	24	13½	47
Henderson,	8	21	11½	83
Breck,	8	20	12½	65
Farquhar,	8	21	11	57
Half Long Guernsey,				
Rawson,	8	19	12½	55
Arlington Long Smooth,				
Rawson,	8	23	12	54
PEAS.				
Champion of England,				
Gregory,	3	9	7½	100
Ferry,	4	11	8½	95
Dreer,	–	–	–	–

PEAS. (Continued).	Time of first germination.	Time of last germination.	Time in which 50% germinated.	Per cent of seeds germinated.
Champion of England (continued)				
Henderson,	7	12	10	93
Breck,	6	17	11½	85
Rawson,	7	19	11	93
Farquhar,	5	17	10½	80
American Wonder,				
Gregory,	3	9	6½	97
Ferry,	3	9	7	95
Dreer,	3	9	6½	100
Henderson,	5	11	8½	97
Breck,	5	11	7	100
Rawson,	6	17	11	70
Farquhar,	5	9	6½	100
McLeans Little Green,				
Gregory,	5	10	7½	95
Ferry,	5	9	7	100
Dreer,	6	12	9	100
Henderson,	5	11	7½	100
Breck,	5	12	8½	97
Rawson,	7	12	10	95
Farquhar,	4	8	6½	90
Black Eyed Marrowfat,				
Gregory,	5	9	7½	100
Ferry,	3	7	6	97
Dreer,	3	9	8	92
Henderson,	5	12	8	100
Breck,	5	15	8	92
Rawson,	7	15	10½	90
Farquhar,	4	11	8	90
RADISHES.				
O. W. T. Fr. Breakfast,				
Gregory,	2	8	2	96
Ferry,	2	9	3	82
Dreer,	2	5	2½	94
Henderson,	2	7	2	97
Breck,	2	12	3	73
Rawson,	2	6	2½	90
Farquhar,	2	9	2	97
Boston Long Scarlet,				
Gregory,	2	9	3	89
Scarlet Turnip,				
Gregory,	2	7	3	93
Early Long Scarlet Short Top,				
Ferry,	2	14	3½	63
Dreer,	2	5	3	96
Henderson,	2	5	2	98
Early Scarlet Turnip Rooted,				
Ferry,	2	11	2½	81
Dreer,	2	12	3	89

RADISHES. (Continued).	Time of first germination.	Time of last germination.	Time in which 50% germinated.	Per cent of seeds germinated.
Early Scar't Turnip Root'd (cont.)				
Henderson,	2	13	3	79
Breck,	2	8	2	100
Rawson,	2	13	2½	94
Farquhar,	2	12	3	65
Long Scarlet,				
Breck,	2	14	3½	71
Rawson,	2	13	3½	62
Farquhar,	2	9	2	98
SQUASHES.				
Boston Marrow,				
Gregory,	8	15	7	95
Ferry,	8	14	8	60
Dreer,	8	9	7	100
Henderson,	11	21	13	80
Breck,	8	15	7	85
Rawson,	8	18	9	80
Farquhar,	8	21	7	90
Marblehead,				
Gregory,	8	15	9	80
Dreer,	14	15	13	55
Henderson,	8	11	8	75
Breck,	8	16	8	95
Rawson,	8	16	10	90
Farquhar,	8	15	8	95
Faxon,				
Gregory,	8	25	10	60
Dreer,	8	12	8	70
Henderson,	8	15	10	85
Breck,	8	18	11	90
Rawson,	8	17	8	90
Farquhar,	8	14	7	85
Hubbard,				
Gregory,	9	16	10	85
Ferry,	8	18	10	75
Dreer,	8	14	9	90
Henderson,	8	10	8	100
Breck,	8	18	8	85
Rawson,	8	11	9	70
Farquhar,	8	11	9	85
TOMATOES.				
Acme,				
Gregory,	5	19	8½	98
Ferry,	6	15	9½	90
Dreer,	4	20	10	89
Henderson,	4	17	6½	100
Breck,	5	20	9½	97
Rawson,	4	19	9½	89
Farquhar	4	22	7	92

TOMATOES. (Continued.)		Time of first germination.	Time of last germination.	Time in which 50% germinated.	Per cent of seeds germinated.
Beauty,					
	Gregory,	4	15	6	98
	Ferry,	4	16	7½	38
	Dreer,	4	9	6	98
	Henderson,	4	17	5	98
	Breck,	4	20	8½	78
	Rawson,	4	17	6½	93
	Farquhar,	4	18	7	96
Perfection,					
	Gregory,	6	16	10	90
	Ferry,	4	17	7½	96
	Dreer,	5	21	9	91
	Henderson,	4	20	8½	90
	Breck,	4	21	10½	81
	Rawson,	7	17	8½	81
	Farquhar,	4	18	9½	87
Lorillard,					
	Gregory,	4	18	9½	78
	Dreer,	4	21	9½	99
	Henderson,	4	22	8	96
	Breck,	4	17	9	97
	Rawson,	4	24	8½	87
	Farquhar,	4	23	11½	76

FIELD TESTS.

All of the seeds with the exception of peas and spinach were planted to ascertain the relative value of the different strains and whether they were true to name. The results of these experiments are given in the following notes and tables. Where no mention is made of the purity of the strains, all proved true to name.

Beets.

Two rows of each variety from each of the seven seedsmen were planted April 20.

Crosby's Early Egyptian was the earliest and was pulled June 19. Early Red Bassano was a few days later, followed by Dewing's Early Blood Turnip and Edmand's Blood Turnip.

With the exception of one lot of Crosby's Early Egyptian which contained a slight mixture of E. R. Bassano all proved true to name; and there was no material difference in value of the different strains.

Lettuce.

The lettuce seed was sown in flats the last of March, picked out in frames and transplanted into open ground.

The Hanson proved true to name in every case and there was little choice in strains.

The strains of Black Seeded Tennis Ball were all good and there was but little variation. Farquhar's and Rawson's formed the largest per cent of good heads; Farquhar's being a little later but larger than Rawson's. All other strains were, however, nearly as good.

Boston Curled proved uniform and true except one lot which was 2 per cent Hanson.

White Seeded Tennis Ball or Boston Market proved true and uniform.

Radishes.

Olive White Tipped French Breakfast:

Gregory, Long, bright scarlet, white-tipped.
Ferry, same as Gregory's.
Dreer, " " " two days earlier.
Henderson, " " "
Breck, " " "
Rawson, " " "
Farquhar, " " "

Boston Long Scarlet:

Gregory, Long Scarlet matures with French Breakfast.

Early Long Scarlet Short Top:

Ferry, Similar to, but 3 days later than Gregory's B. L. S.
Dreer, Same as Ferry's.
Henderson, " " "

Long Scarlet:

Rawson, Similar to Gregory's B. L. S., 3 days later.
Farquhar, " " " 5 " "

Early Scarlet Turnip Rooted:

Ferry, Round scarlet very fine.
Dreer, " " " " 2 days earlier.
Henderson, Similar to Ferry's.
Breck, " "
Rawson, " " 3 days earlier.
Farquhar, " "

CABBAGES.	Per cent headed by Aug. 1.	Solidity.	total per cent marketable heads.
Henderson's Early.			
Gregory,	25	9	92
Ferry,	33	9	100
Dreer,	15	8	92
Henderson,	40	9	100
Breck,	15	8	92
Rawson,	25	9	100
Farquhar,	15	9	100
All Seasons,			
Gregory,		9	100
Ferry,		9	100
Dreer,	15	9	92
Henderson,		9	84
Breck,		8	100
Rawson,		8	84
Farquhar,		9	100
Fotler's Brunswick,			
Gregory,		9.5	92
Ferry, (Early Imperial Flat)		8	92
Dreer,		9	84
Henderson,		9	100
Breck,		8	92
Rawson,		9.5	92
Farquhar,		9	84
Early Jersey Wakefield,			
Gregory,	45	8	92
Ferry,	45	9.5	92
Dreer,	25	9.5	84
Henderson,	60	9	100
Breck,	25	9	84
Bawson,	40	9	92
Farquhar,	45	9	100

CELERY.	Average length of stalk.		Texture.	Purity of seed.
	ft.	in.		
White Plume,				
Gregory,	2	6	9	9.9
Ferry,	2	6	9	9.9
Dreer,	1	9	8	9.9
Henderson,	1	6	9	9.9
Breck,	1	9	8	10
Rawson,	2		9	10
Farquhar,	2		9	10
Giant Pascal,				
Gregory,	2		9	10
Ferry,	1	9	9	10
Dreer,	2	3	9.5	9.9
Henderson,	2		7	9.9
Breck,	1	9	9	10
Rawson,	1	9	9.5	10
Farquhar,	1	9	8	10
Boston Market,				
Gregory,	1	6	9	10
Ferry,	1	6	9.5	10
Dreer,	1	9	9.5	9
Henderson,	3		7	7
Breck,	3		7	7
Rawson,	1	6	10	10
Farquhar,	1	6	10	10
Paris Golden or Golden Yellow,				
Gregory,	1	9	9	10
Ferry,	1	6	9	9.9
Dreer,	1	6	9	9.9
Henderson,	1	6	9	10
Breck,	1	9	9	9.9
Rawson,	1	6	9	9.9
Farquhar,	1	6	9	9.9

CUCUMBERS.	Yield previous to Aug. 9.	Total product per hill.
Talby's Hybrid,		
Gregory,	1	42
Ferry,	4	40
Dreer,	2	40
Henderson,	0	26
Breck,	2	48
Rawson,	1	37
Farquhar,	4	42
Improved White Spine,		
Gregory,	2	38
Ferry,	2	30
Dreer,	1	31
Henderson,	6	48
Breck,	4	39
Rawson,	2	30
Farquhar,	7	53
Long Green,		
Gregory,	5	37
Ferry,	3	32
Dreer,	2	33
Henderson,	3	36
Breck,	1	40
Rawson,	0	27
Farquhar,	3	44
Early Cluster,		
Gregory,	4	28
Ferry,	1	32
Dreer,	7	34
Henderson,	4	38
Breck,	5	46
Rawson,	3	41
Farquhar,	5	49

ONIONS.	Yield per row. lbs.	Average weight. oz.	Per cent immature onions.	Uniformity.
Early Round Yellow Danvers,				
Gregory,	122	3.2	1	9
Early Danvers,				
Ferry,	123	4.1	3	8
Henderson,	110	3.3	5	7
Breck,	88	4.1	2	8
Rawson,	55	3.3	2	8
Farquhar,	61	3.7	1	9
Giant Rocca,				
Gregory,	159	6.5	10	8
Ferry,	150	7.	10	7
Dreer,	145	5.	20	6
Henderson,	138	5.7	16	7
Breck,	119	6.3	23	6
Rawson,	119	9.5	7	9
Farquhar,	100	5.4	17	8
Large Red Wethersfield,				
Gregory,	95	4.7	2	9
Ferry,	106	4.9	3	8
Dreer,	86	5.	5	8
Henderson,	105	4.4	4	8
Breck,	80	4.6	2	9
Rawson,	71	4.	1	9
Farquhar,	56	4.7	3	9
White Portugal,				
Gregory,	107	3.2	3	9
Ferry,	76	4.	4	8
Dreer,	96	3.	3	8
Henderson,	76	3.8	6	8
Breck,	65	2.6	4	9
Rawson,	77	3.3	5	8
Farquhar,	63	3.2	3	8

PARSNIPS.	Yield per row. lbs.	Quality for market.	Uniformity.
Large Dutch,			
Gregory,	108	6	8
Abbott's Improved Hollow Crowned,			
Gregory,	99	9	9
Rawson,	123	8	9
Guernsey,			
Ferry,	99	8	9
Henderson,	124	8	9
Breck,	109	7	9
Farquhar,	111	9	9.5
Long White Dutch,			
Ferry,	120	8	9
Student,			
Dreer,	105	7	8
Henderson,	126	8	9
Breck,	104	8	9
Farquhar,	98	9	9.5
Large Sugar,			
Dreer,	94	6	8
Long Smooth,			
Dreer,	112	8	9
Henderson,	132	7	8.5
Breck,	115	7	8.5
Farquhar,	102	9	9
Half Long Guernsey,			
Rawson,	101	8	9
Arlington Long Smooth,			
Rawson,	107	8	9

SQUASHES.	Total product of 6 hills	Average weight.		Color.	Con-formity to type.	Uni-formity.
	lbs.	lbs.	oz.			
Boston Morrow,						
Gregory,	87	9	10	10	9	9
Ferry,	50	8	5	10	9	9
Dreer,	154	7	6	10	9	9
Henderson,	85	8	8	10	9	9
Breck,	120	9	4	9	10	9
Rawson,	115	7		8	9	9
Farquhar,	71	6	9	10	10	9.5
Hubbard,						
Gregory,	217	8	7	10	9	9
Ferry,	183	11	8	10	9.5	9
Dreer,	46	9	3	9	7	9
Henderson,	72	7	3	9	8	9
Breck,	128	8	8	9	9	8
Rawson,	118	8	6	8	9	9
Farquhar,	173	9	10	9	10	10
Faxon,						
Gregory,	149	4	7	*mx	9	9
Dreer,	186	4	10	mx	9	8
Henderson,	152	6	14	mx	6	5
Breck,	244	5	15	mx	7	6
Rawson,	157	5	13	mx	6	5
Farquhar,	176	6	4	mx	8	7
Marblehead,						
Gregory,	76	6	14	9	9	8
Dreer,	89	7	7	8	6	8
Henderson,	152	8	6	9	9	10
Breck,	58	7	4	10	8	9
Rawson,	78	10	5	10	9	9
Farquhar,	62	4	7	9	8	7

*mx. For mixed. All colors from light yellow to dark green.

TOMATOES.	Yield previous to Aug. 28.			Total yield of ripe fruit.			Yield of green fruit.	Average weight of ripe specimens
	No.	lbs.	oz.	No.	lbs.	oz.	lbs.	oz.
Acme,								
Gregory,	1		6	31	10	15	15	5.7
Ferry,	3	1	1	32	11	6	10¼	5.8
Dreer,	2		13	22	7	4	10	5.3
Henderson,	2		8	18	6	9	11⅓	5.8
Breck,	1		6	17	6	5	6½	5.9
Rawson,	2		10	33	14	2	7⅔	6.9
Farquhar,	3	1	2	23	8	9	5½	5.7
Beauty,								
Gregory,	2	1		14	6	4	8½	7.1
Ferry,	1		8	16	6	10	11	6.3
Dreer,	1		6	14	5	10	8½	6.7
Henderson,	0		0	20	12	2	7	9.5
Breck,	1		7	20	8	1	12	6.4
Rawson,	3	1	5	23	11	0	6⅔	7.6
Farquhar,	0		0	19	8	10	4½	7.2
Perfection,								
Gregory,	1		6	23	8	10	9¼	5.8
Ferry,	0		0	29	10	9	8¼	6.2
Dreer,	1		8	19	9		10	7.7
Henderson,	2		15	24	7	14	8	5.2
Breck,	1		5	16	6	5	2½	7.2
Rawson,	0		0	12	5	7	6	7.2
Farquhar,	1		5	27	9	4	5	5.4
Lorillard,								
Gregory,	0		0	13	7	11	6½	9.3
Dreer,	0		0	14	5	7	8	6.2
Henderson,	1		6	26	9	2	5½	5.6
Breck,	2		15	29	12	2	5	6.5
Rawson,	0		0	19	7	2	8	6.1
Farquhar,	1		6	28	11	6	6	6.4

The average per cent of vitality of the seeds was as follows :

Beets 77	Melon 80	Onion 80	Radish 86
Cabbage 83	Cucumber 87	Parsnip 71	Squash 81
Cauliflower 87	Lettuce 97	Pea 94	Tomato 90
Celery 70			

One sample of lettuce contained 4.5 per cent and another 1.7 per cent of impurities, mostly gravel and lumps of earth. In all other cases the seeds were very free from impurities.

In one instance a package of seed marked Champion of England Pea, proved to be sweet corn ; but in no case was there any evidence of an attempt on the part of the seedsman to sell seeds untrue to name, and in nearly every instance, the strains were pure and free from mixture.

Spraying for the Destruction of Insects and Fungous Growths.

The results of spraying during the past season to protect crops from insects and fungous pests, again show the great benefits derived from this work.

All of the fruit and vegetable crops grown on the college grounds generally injured by the above pests, were treated according to the spraying calendar of 1896 and in most cases with marked beneficial results, only one illustration of which will be offered.

SPRAYING APPLE TREES.

Four Baldwin and five R. I. Greening apple trees were selected; three of the former and four of latter variety were sprayed leaving as a check one tree of each kind.

Results: The trees sprayed gave results as follows: Baldwin, 3.37% more picked apples, 16% less windfalls, 50% less wormy fruit, and 93% less scabby fruit than the unsprayed trees; R. I. Greening, 100% more picked fruit, 49% less windfalls, 81% less wormy fruit and 72% less scabby fruit.

Equally good results were obtained with many other kinds of fruits.

PUMPS AND NOZZLES.

There has been considerable improvement made in the pumps and nozzles put upon the market in the past year, and many new pumps have been offered. Whatever the kind of pump purchased it is important that it be used carefully, that the spraying material, if containing coarse particles, be carefully strained before use, that all parts be kept well oiled and after using that the pump be cleaned by pumping sufficient clear water through it to clear it of corroding materials.

Good judgment and considerable mechanical skill must be exercised to get the best results with any complicated machine, and only those persons possessing these qualifications should be allowed to use the pumps.

KEROSENE EMULSION.

Formula. ½ lb. common bar soap,
2 gallons common kerosene.

Cut the soap into small pieces or shavings and dissolve in about two gallons of hot water. While still hot, pour in the kerosene and with the hand pump or syringe, pump it back and forth until a thick butter-like substance is formed. In this condition the kerosene is divided into very minute globules and will be readily diluted or suspended in water.

Before using, add water enough to make

(A) 10 gallons of emulsion
(B) 20 " " "

A to be used when the insects are in large numbers and the foliage is known not to be easily injured by it.

Pyrethrum Powder and *Hellebore* should be obtained in a perfectly fresh condition and be kept in glass stoppered jars.

SPRAYING CALENDAR.

PLANT.	FIRST APPLICATION.	SECOND APPLICATION.
APPLE . . . . *(Scab, codlin moth, bud moth. Tent caterpillar, canker worm, plum curculio.)*	When buds are swelling, Bordeaux.	If canker worms are abundant just before blossoms open, Bordeaux and Paris green.
BEAN . . . . *(Anthracnose.)*	When third leaf expands, Bordeaux.	10 days later, Bordeaux.
CABBAGE . . . . *(Worms.)*	Insect powder	7-10 days later Insect powder.
CHERRY* . . . . *(Rot, aphis, slug. Black Knot.)*	As buds are breaking, Bordeaux; when aphis appears, kerosene emulsion.	When fruit has set, Bordeaux. If slugs appear, dust leaves with air slaked lime. Hellebore.
CURRANT GOOSEBERRY . . . . . *(Worms. Leaf blight.)*	At first sign of worms, hellebore.	10 days later, hellebore. Bordeaux.
GRAPE . . . . *(Fungous diseases. Rose bug.)*	In Spring when buds swell, Bordeaux.	Just before flowers unfold, Bordeaux.
NURSERY STOCK . . . . *(Fungous diseases.)*	When first leaves appear, Bordeaux.	10-14 days, repeat first.
PEACH, NECTARINE . . *(Rot, mildew.)*	As the buds swell, Bordeaux.	When fruit has set, Bordeaux.
PEAR . . . . *(Leaf blight, scab, psylla, codlin moth.)*	As buds are swelling, Bordeaux.	Just before blossoms open, Bordeaux. Kerosene emulsion when leaves open, for psylla.
PLUM* . . . . *(Curculio. Black knot, leaf blight, brown rot.)*	When buds are swelling Bordeaux.	When blossoms have fallen, Bordeaux and Paris green. Begin to jar trees for curculio.
QUINCE . . . . *(Leaf and fruit spot.)*	When blossom buds appear, Bordeaux.	When fruit has set, Bordeaux.
RASPBERRY, BLACKBERRY, ... DEWBERRY, *(Anthracnose. Leaf blight.)*	Before buds break, Bordeaux.	Bordeaux, just before the blossoms open.
STRAWBERRY . . . . . *(Rust.)*	As soon as growth begins, with Bordeaux.	When first blossoms open, spray young plantation, Bordeaux.
TOMATO . . . . *(Rot, blight.)*	Before appearance of blight or rot, Bordeaux.	Repeat first if diseases are not checked. Fruit can be wiped if disfigured by Bordeaux.
POTATO . . . . *(Flea beetle, Colorado beetle, blight and rot.)*	Spray with Paris green and Bordeaux when ¼ grown.	Repeat before insects become numerous.

*Black knot on plums or cherries should be cut and burned as soon as discovered.

STEAM SPRAYING OUTFIT.

The steam spraying outfit constructed last season gave good results, but considerable more skill is needed in using such an equipment than with the ordinary barrel pump, and the first cost, about $200, is such that only those engaged in a very large business, associations or communities would find it profitable.

THIRD APPLICATION.	FOURTH APPLICATION.	FIFTH APPLICATION.
When blossoms have fallen, Bordeaux and Paris green.	8-12 days later, Bordeaux and Paris green.	10-14 days later, Bordeaux.
14 days later, Bordeaux.	14 days later, Bordeaux.	Spraying after the pod is one-half grown will injure them for market.
7-10 days later, Insect powder.	Repeat third in 10-14 days if necessary.	
10-14 days if rot appears, Bordeaux.	10-14 days later, weak solution of copper sulphate.	
If worms persist, hellebore.	After fruit is gathered, Bordeaux.	
When fruit has set, Bordeaux.	2 to 4 weeks later, Bordeaux.	2 to 4 weeks later, if any disease appears, weak solution of copper sulphate.
10-14 days repeat first.	10-14 days repeat first.	10-14 days, repeat first.
When fruit is one half grown, Bordeaux.	5-7 days later, weak solution of copper sulphate.	5-7 days later, repeat fourth.
After blossoms have fallen, Bordeaux and Paris green. Kerosene emulsion, if necessary.	8-12 days later, repeat third.	10-14 days later, Bordeaux.
10-14 days later, Bordeaux.	10-23 days later, Bordeaux.	10-20 days later, weak solution of copper sulphate.
10-20 days later, Bordeaux.	10-20 days later, Bordeaux.	10-20 days later, Bordeaux.
(Orange or red rust is treated best by destroying the plant.)	Spray after fruit is gathered with Bordeaux.	
Spray young plantation Bordeaux.	Repeat third if foliage rusts.	
Repeat first when necessary.		
Repeat for blight, rot and insects as potatoes approach maturity.		

*For aphides or plant lice use kerosene emulsion on all plants.

INSECTICIDES.

While there are many new insecticides offered, there is so little exact knowledge of their effect upon farm and garden crops that until further trial is made we can only recommend for general use Paris green and hellebore for chewing insects and kerosene emulsion for sucking insects, with pyrethrum or insect powder in a very few cases.

FUNGICIDES.

BORDEAUX MIXTURE.

Formula. 4 lbs. Copper Sulphate, (*Blue Vitriol*).
4 lbs. Caustic Lime (Unslaked Lime).

Dissolve the copper in hot water. (If suspended in a basket or sack in a tub of cold water it will however dissolve in from two to three hours.)

The lime is then slaked in another vessel adding water slowly that it may be thoroughly slaked. When both are cool, pour together, straining the lime through a fine mesh sieve or burlap strainer, and thoroughly mix. Before using, add water enough to make 50 gallons of the mixture.

The active agent in this mixture is the copper, the lime being used simply to hold it in place upon the foliage and branches of the plants sprayed. Here it is given up gradually, destroying the spores of the fungi as they are brought in contact with it by the surrounding atmosphere.

Should the lime be air slaked at all more than four pounds may be needed as it will have lost much of its strength.

This fungicide is recommended as more satisfactory than any other, from the fact that it adheres a long time to the branches, buds and leaves and seldom causes any injury to the foliage.

It has been found more effectual if made up fresh for each application. Two or three thorough applications give better results than many light ones.

When both fungous growths and insects attack a crop, Paris green should be applied with the Bordeaux, as in a combined state both are as effective as if used singly, one-half of the labor is saved and there is less danger from injury to the foliage by the Paris green than if used alone.

DILUTE COPPER SULPHATE SOLUTION.

After the fruit has nearly matured it is often disfigured by the adhesion of the Bordeaux mixture, and in place of the Ammoniacal carbonate of copper recommended in Bulletin No. 37, we would advise the use of copper sulphate 2 oz. to 50 gallons of water. The foliage of many plants will stand a much stronger solution, but this is as concentrated as can be generally used.

DRY BORDEAUX MIXTURE.

Several samples of the dry Bordeaux mixture were sent to the Station for trial and some brands purchased, all of which were given a careful trial with the following results:

a. That in the dry powdered form it is difficult to distribute over the leaves without great loss.

b. That it does not adhere well to the leaves even when they have been wet with dew or rain.

c. That the first heavy rain washes all off.

d. That little or no beneficial results attended its use.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 45.

1. General Discussion on Commercial Fertilizers.
2. Analyses of Fertilizing Materials sent on for Examination.
3. New Fertilizer Law.

MARCH, 1897.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1897.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Fred W. Mossman, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Stephen W. Fletcher, B. Sc.,	*Assistant Horticulturist.*
Benjamin K. Jones, B. Sc.,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

I.

General Discussion on Commercial Fertilizers.

By C. A. Goessmann.

A judicious selection of fertilizers from among the various brands offered for patronage, requires in the main, two kinds of knowledge, namely that the brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost; and that it contains them in such form and such proportions as will best meet under existing circumstances the special wants of soil and crop.

In some cases it may be only phosphoric acid or nitrogen or potash; in others two of them; and in others again all three.

A remunerative use of commercial fertilizers can only be secured by attending carefully to these considerations.

To assist farmers in selecting their fertilizers with reference to *the wants of the crops* they wish to cultivate, the writer has for years published in his annual reports a compilation of the analyses of the farm and garden crops to serve as a guide to all interested in a rational mode of manuring plants. Copies of these compilations of analyses may be secured by asking for them at the office of the Hatch Experiment Station at Amherst, Mass.

An economical use of manurial substances from any source is only possible after the local condition of the soil under consideration as well as the special wants of the crops to be raised, are each duly considered. It becomes the business of every progressive farmer to acquire such information as is called for to select intelligently from the various manurial resources at his disposal, those materials which will meet best *his wants* for a complete fertilizer.

The practice of adding to the manurial refuse materials of the farm as stable manure, vegetable compost, etc., such single commercial manurial substances as will enrich them in the direction desirable for any particular crop to be raised, does not yet receive that degree of general attention, which it deserves. An addition of potash in the form of muriate or sulphate of potash, or of phosphoric acid in the form of fine ground South Carolina or Florida soft phosphate, etc., will in many instances not only improve their general fitness as complete manure,—but quite frequently permit a material reduction in the amount of barnyard manure ordinarily considered sufficient, to secure satisfactory results.

BARNYARD MANURE.

(Average composition of seventy-five samples.)

Moisture,	67.00	per cent	or	1340.0	pounds	per ton
Nitrogen,	.52	"	"	10.4	"	"
Potassium oxide,	.56	"	"	11.2	"	"
Phosphoric acid,	.39	"	"	7.8	"	"

The average barnyard manure contains, it will be noticed from the above statement, a larger percentage of nitrogen, as compared with its potash and phosphoric acid than is generally considered economical. An addition of from thirty to forty pounds of muriate of potash and of one hundred pounds of fine ground natural phosphates (soft Florida or South Carolina floats) per ton of barnyard manure would greatly increase its value as an efficient and economical general fertilizer.

On valuation.—The market value of the higher grades of agricultural chemicals and compound fertilizers depends in the majority of cases on the amount and the particular form of three essential articles of plant food which they contain, i. e., nitrogen, potash and phosphoric acid. Supply and demand control the temporary market prices not less in the fertilizer trade than in other lines of commercial business.

The *approximate* market value of a fertilizer, simple or compound is obtained, by multiplying the pounds contained in a ton of two thousand pounds by the trade value per pound of each of the three above stated essential constituents of plant food present.

The same course is adopted with reference to the different forms of each,—wherever different prices are recognized in the trade.

Adding the different values—per ton—obtained, we find the total value per ton at the principal place of distribution.

As farmers are quite frequently not in the position to secure the desired information regarding the market cost of fertilizers they wish to secure, the official inspectors of commercial fertilizers have aided them for years in ascertaining the current market prices of the leading or standard raw materials, as

Sulphate of Ammonia,
Nitrate of Soda,
Muriate of Potash,
Sulphate of Potash,
Dried Blood,
Dried Ground Meat,
Dry Ground Fish,
Azotin,
Ammonite,
Castor Pomace,
Bone and Tankage,
Plain Superphosphates, etc.

which serve largely in the manufacture of good fertilizers for our market,—and have published the results of their inquiries in form of tables, stating the average trade values per pound for the six months preceding, of the different kinds and forms of fertilizing materials at the leading places of distribution. The results of a recent meeting of the representatives of the Agricultural Experiment Stations of Connecticut, Rhode Island, New Jersey, Vermont and Massachusetts are presented below:

TRADE VALUES
OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1897. *Cents per pound.*
Nitrogen in ammonia salts,	13.5
" " nitrates,	14.
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	14.
" " " cotton-seed meal, linseed meal and in castor pomace	12.
" " " fine ground bone and tankage,	13.5
" " " medium ground bone and tankage,	11.
" " " coarse bone and tankage,	8.

Phosphoric acid soluble in water,	5.5
" " soluble in ammonium citrate,	5.
" " in fine bone and tankage,	5.
" " in medium bone and tankage,	4.
" " in coarse bone and tankage,	2.5
" " in fine ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	5.
" " insoluble (in am. cit.) in mixed fertilizers,	2.
Potash as Sulphate, free from Chlorides,	5.
" " Muriate,	4.5

The market value of low priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the current market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical conditions for a speedy action, exert as a rule, a decided influence on their selling price.

The *mechanical condition of any fertilizing material*, simple or compound, deserves the most serious consideration of farmers, when articles of a similar chemical character are offered for their choice. The degree of pulverization controls almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant-food throughout the soil.

The *state of moisture* exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from 50 to 100 per cent in commercial value, on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Consumers of commercial manurial substances will do well to buy whenever practicable, on a guarantee of composition of their essential constituents; and to see to it that the bill of sale recognizes the point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

It is of the first importance when buying fertilizers for home consumption to consider their cost with reference to what they promise to furnish. The high priced fertilizers may prove in many instances cheaper than the lower priced one—when judged from that standpoint.

Our present laws for the regulation of the trade in commercial fertilizers, include not only the various brands of compound fertilizers, but also all materials single or compound without reference to source, used for manurial purposes when offered for sale in our market.

A large percentage of commercial manurial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community to a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the composition of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

On analysis of fertilizing materials at the station.—Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances—to be used for fertilizing purposes—coming through officers of agricultural societies and farmers' clubs within the State, will receive hereafter, as in the past, attention first, and in the order that applications arrive at the office of the station. The results will be returned without charge for services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration, whenever the results promise to be of a more general interest. For obvious reasons no work can be carried on at the station, *free of charge*, the results of which are not at the disposal of the managers for publication, if deemed advisable in the interest of the citizens of the State.

All parcels containing samples of fertilizers for examination must have express charges prepaid; they may be addressed to C. A. Goessmann, Hatch Experiment Station, Amherst, Mass. To avoid mistakes and delay, notice should also be given by postal card, that a package has been sent by express and the owner's name should be stated inside or outside of the packages.

II.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

251—255. WOOD ASHES.

I. Received from Sudbury, Mass.
II. Received from Fall River, Mass.
III. Received from Boston, Mass.
IV. Received from Billerica, Mass.
V. Received from Walpole, N. H.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	14.05	.45	5.29	14.25	18.39
Potassium oxide,	5.16	8.81	5.12	5.96	3.80
Phosphoric acid,	.82	2.82	1.68	11.50	.34
Insoluble matter,	14.54	15.43	18.88	*	10.26

256—260. WOOD ASHES.

I. Received from Walpole, N. H.
II. Received from Hatfield, Mass.
III. Received from Townsend, Mass.
IV. Received from Hatfield, Mass.
V. Received from Boston, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.28	7.97	.91	1.79	1.65
Potassium oxide,	4.28	5.46	1.34	5.41	4.98
Phosphoric acid,	1.28	.92	1.21	1.48	.66
Insoluble matter,	8.02	17.41	11.86	*	*

261—264. WOOD ASHES.

I. Received from Fall River, Mass.
II. Received from Concord, Mass.
III. Received from Westfield, Mass.
IV. Received from Westfield, Mass.

*Not determined.

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	1.72	14.07	2.97	2.31
Potassium oxide,	5.54	5.38	6.04	5.76
Phosphoric acid,	1.92	1.50	.92	1.10
Insoluble matter,	*	10.85	38.39	40.09

265–268. ASHES.

I. Magnolia ashes from Florida sent on from Marlboro, Mass.
II. Picker waste ashes sent on from Shirley, Mass.
III. Cotton seed hull ashes sent on from No. Hatfield, Mass.
IV. Cotton seed hull ashes sent on from Sunderland, Mass.

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	1.58	.28	7.96	9.17
Potassium oxide,	2.56	6.56	19.72	24.16
Phosphoric acid,	.45	1.18	9.68	8.12
Insoluble matter,	6.12	63.43	9.62	

269—273. PEAT—MUCK—SOIL.

I. Peat sent on from Marshfield, Mass.
II. Peat sent on from Mt. Auburn, Mass.
III. Muck sent on from East Walpole, Mass.
IV. Soil sent on from Marshfield, Mass.
V. Soil from Sudbury River sent on from Wayland, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.15	70.56	53.42	1.73	33.87
Organic and volatile matter	72.88	12.93	9.68	7.70	19.50
Nitrogen,	2.10	.128	.158	.38	.52
Insoluble matter,	*	*	36.90	*	44.53

274—277. MIXED FERTILIZERS.

I. Received from Sunderland, Mass.
II. Received from Agawam, Mass.
III. Received from Rock, Mass.
IV. Received from Rock, Mass.

*Not determined.

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	14.35	5.70	14.01	14.34
Nitrogen,	2.12	2.79	2.60	1.98
Potassium oxide,	5.68	5.38	1.72	*
Total phosphoric acid,	11.66	9.78	11.54	8.81
Sol. phosphoric acid,	*	2.58	*	*
Reverted phosphoric acid,	*	6.66	*	5.61
Insol. phosphoric acid,	*	.54	*	3.20
Insoluble matter,	*	*	2.40	4.23

278—282. TANKAGE AND GROUND BONE.

I. & II.	Tankage sent on from Lawrence, Mass.
III.	Tankage sent on from Agawam, Mass.
IV.	Tankage sent on from South Hadley Falls, Mass.
V.	Fine ground bone sent on from Northboro, Mass.

	Per Cent.				
	I.	II.	III.	IV	V.
Moisture at 100° C.,	3.74	3.74	5.58	4.88	4.03
Nitrogen,	5.34	5.34	5.63	7.31	4.99
Total phosphoric acid,	17.48	17.48	14.20	11.76	22.66
Available phosphoric acid,	*	*	*	4.72	6.74
Insoluble phosphoric acid,	*	*	*	7.04	15.92

283—285. COTTON WASTE.

I.	Picker waste sent on from Shirley, Mass.
II.	Waste size sent on from Shirley, Mass.
III.	Cotton waste sent on from Greenfield, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	7.35	74.00	7.18
Nitrogen,	.91	.006	1.03
Potassium oxide,	.88	.40	1.40
Phosphoric acid,	.17	.008	.35
Insoluble matter,	10.29	1.43	26.03

* Not determined.

286—289. COTTON SEED MEAL.

I. Received from Hatfield, Mass.
II. Received from Springfield, Mass.
III. & IV. Received from North Hatfield, Mass.

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.64	7.74	6.46	6.82
Nitrogen,	6.84	4.74	7.32	6.34

290—293. COTTON SEED MEAL.

I., II. & III. Received from North Hatfield, Mass.

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	6.49	6.26	6.19
Nitrogen,	7.62	7.10	7.55

294— POTASH REFUSE.

By product from manufacture of Potassium cyanide, sent on from Fairhaven, Mass.

	Per Cent.
	I.
Moisture at 100° C.,	39.23
Nitrogen,	.96
Potassium oxide,	7.36
Phosphoric acid,	Trace

LAWS FOR THE REGULATION OF THE TRADE IN COMMERCIAL FERTILIZERS IN MASSACHUSETTS.

Legislative Acts for 1896, Chapter 297.

An Act to regulate the sale of commercial fertilizers.

Be it enacted, etc., as follows:

Section 1. Every lot or parcel of commercial fertilizer or fertilizer material sold or offered or exposed for sale within this Commonwealth shall be accompanied by a plainly printed statement, clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade-mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the location of the factory, and a chemical analysis stating the percentage of nitrogen, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Section 2. Before any commercial fertilizer is sold or offered or exposed for sale the importer, manufacturer or party who causes it to be sold or offered for sale within this Commonwealth shall file with the director of the Hatch experiment station of the Massachusetts Agricultural College a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request, a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Section 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or fertilizer material shall pay for each brand, on or before the first day of May annually, to the director of the experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand of fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two the director of said station shall issue certificates of compliance with this act.

SECTION 4. No person shall sell or offer or expose for sale in this Commonwealth any pulverized leather, hair or wool waste, raw, steamed, roasted or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany or go with every parcel or lot of the same.

SECTION 5. Any person selling or offering or exposing for sale any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence and one hundred dollars for each subsequent offence.

SECTION 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use and not to sell in this commonwealth.

SECTION 7. The director of the experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or fertilizer material to be made annually, and shall publish the results from time to time, with such additional information as the circumstances render advisable, provided such information relates only to the composition of the fertilizer or fertilizer material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or fertilizer material which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest, or their representative, and taken from a parcel or a number of packages which shall not be less than ten per cent of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels, and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn, and the time and place of drawing; and said label shall also be signed by the director or his deputy and by the party or parties in interest, or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station.

Section 8. Chapter two hundred and ninety-six of the acts of the year eighteen hundred and eighty-eight is hereby repealed.

Section 9. This act shall take effect on the first day of November in the year eighteen hundred and ninety-six.

[*Approved April 17, 1896.*

Instructions to Manufacturers, Importers, Agents, and Sellers of Commercial Fertilizers or Materials used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this state must be accompanied:

   First, with a distinct statement of the name of each brand offered for sale, the name of the manufacturer and place of factory.

   Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

   Third, with the fee charged by the state for a certificate, which is five dollars for each of the following articles: nitrogen, phosphoric acid and potassium oxide guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes offered for sale in this state.

3. The certificate of compliance with our state laws must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they desire after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

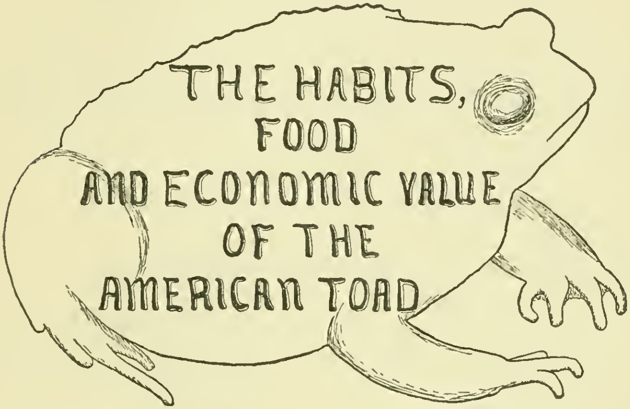
All inquiries regarding the sales of commercial fertilizers, etc., may be addressed to C. A. Goessmann, Chemist in charge of the official inspection of these articles, Amherst, Mass.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS
AGRICULTURAL COLLEGE.

BULLETIN NO. 46.



THE HABITS, FOOD AND ECONOMIC VALUE OF THE AMERICAN TOAD

APRIL, 1897.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1897.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Fred W. Mossman, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Stephen W. Fletcher, B. Sc.,	*Assistant Horticulturist.*
Benjamin K. Jones, B. Sc.,	*Assistant in Foods and Feeding.*
James L. Bartlett,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

Division of Entomology.

The following paper on the habits and food of the American toad has been prepared by my assistant, Mr. Kirkland, from observations made while in the employ of the Gypsy Moth Committee. The results obtained form a considerable addition to our knowledge of the habits and food of the toad and are published here by permission of the committee.

C. H. FERNALD.

The Habits, Food and Economic Value

OF THE

AMERICAN TOAD,

Bufo lentiginosus americanus (LeC.)

BY A. H. KIRKLAND, M. S.,

Assistant Entomologist to the Gypsy Moth Committee.

The investigations forming the basis of this paper were made by the writer at spare moments during the summer of 1896. They were not undertaken with a view of exhausting the subject, but rather as an attempt to obtain some adequate idea of the value or non-value of the toad as a destroyer of insects. During the summer of 1895, while studying the habits of the natural enemies of the gypsy moth, the writer observed that in brushlands, large numbers of this insect were destroyed by the toad. To gain farther information concerning its feeding habits, the available literature on batrachians was consulted with the result that an abundance of generalities was found with but few detailed statements of fact. By agriculturists the toad is considered a beneficial creature; by some entomologists, a good collector of beetles. This appears to represent the sum of the knowledge of the feeding habits of the toad. From the general distribution of this animal, its common occurrence near the abodes of man and its known insectivorous habits, it seemed that an investigation of its feeding habits and food could not be otherwise than interesting and profitable. Owing to the pressure of other duties the writer has been unable to devote to this work the amount of time the subject deserves and no claim is made for completeness of results. It is hoped, however, that they may suffice to call attention to the habits and value of the animal to which they pertain and thus possibly induce others to prosecute farther an investigation of this most interesting subject. At this point, the writer would acknowledge his indebtedness to Prof. C. H. Fernald and President H. H. Goodell for assistance in bibliographical research, and to the former for many valuable criticisms and suggestions. Acknowledgements should also be made to Dr. Leonhard Stejneger, Dr. C. Hart Merriam and Prof. F. E. L. Beal for valuable information.

ANCIENT IDEAS CONCERNING THE TOAD.

That the early students of natural history were in a measure cognizant of the habits of the toad, there is ample evidence in the older writings upon animals, but most unfortunately from a scientific standpoint, the ancient savants who did so much to establish the study of nature, too frequently confounded current superstition with actual fact, and hence we find the early literature upon this interesting batrachian teeming with vague and ludicrous fancies as to its venomous qualities, its medicinal virtues or, most commonly, the hidden toad-stone of priceless value. In this connection it may not be amiss to briefly cite some of these ancient fanciful ideas, for, although they pertain in general to the European species which are distinct from the American, it is quite evident that when our worthy ancestors explored the fauna of our "stern and rock bound coast" they had but little difficulty in adapting the whole host of venerable old world traditions to the new world toads, and thus implanted here superstitions, which, strange as it may seem, still have their devout adherents.

In glancing through the older literature on the toad, we find that the three different groups of fancies indicated above are generally contemporaneous and strangely interwoven. The baleful venom, the medicinal virtues and the valuable jewel, frequently appear in the same writing associated with minor superstitions, which, though equally ludicrous, never appear to have reached the popularity of the ones cited.

That the toad was venomous was not doubted by the ancients. It was disagreeable, ugly in appearance and "the most deformed and hideous of all animals," hence it must be venomous. Pliny writes of "the venomous frogs and todes called Rubetae which live both on land and in the water." Juvenal makes the Roman dames poison thriftless or uncongenial husbands with a broth made from the toad's entrails. Aelian considered its venom so potent that people might be killed by its breath or glance. Erasmus bears witness to this current belief in his absurd story of the toad and the sleeping monk. Lyly referring to the toad-stone says, "The fayrer the stone is in the toade's head the more pestilent the poyson is in hir bowelles." The uses of adversity are by Shakespeare compared to the "ugly and venomous" toad. According to Valisnerii, the German soldiers, who in 1692 captured the castle of Arceti, amused themselves after the manner of the local peasants in catching frogs and preparing them for the table. To the great joy of the peasants the soldiers did not discriminate between frogs and toads and both were cooked. The natives felt that the hand of Providence had interposed in their behalf and that a wholesale poisoning of their hated captors would result. Soon however their joy was changed to anxiety, to astonishment, and then to a superstitious awe of the gastronomic abilities of the Teutons, for no evil effects resulted. Solenander gives us the interesting account of a thrifty housewife who, finding the support of a sickly husband too great a burden, decided to relieve herself of her marital incubus by means of poison. Carefully calcining a toad, she secretly administered the ashes in a cup of warm drink to her trusting companion and then prepared herself for her anticipated bereavement. To her surprise, the expected did not happen and after several trials the worthy woman became discouraged and the husband was allowed to live to a ripe old age. The Gallic antipathy to the toad is proverbial and may have sprung from the belief that the animal was poisonous. That it is not so regarded by all the French market-men is evident from the statement of Bosc that unscrupulous dealers frequently adulterate their stock of frogs' hind legs with the corresponding members of toads.

A considerable part of the early study of chemistry seems to have been devoted to an investigation of poisons and a search for antidotes. The doctrine of "similia similibus curantur" was apparently firmly believed and from the most venomous animals and poisonous plants, materials for panaceas, charms and talismans were commonly sought, their efficacy varying directly with the faith of the possessor. It is impossible to state who first promulgated the idea that the toad was the possessor of a stone or jewel that would detect poisons, but it is evident that the belief was current at an early date, as is shown by the following quotation from Brand: "Dr. Bell pointed out that in a translation from Pliny entitled 'Wonders of Nature,' 1569, there is this passage: 'There is found in the heades of old and great *toades* a stone, which they call *borax* or *stolon*; it is most commonly found in the head of a *hee toade*, of power to repulse poisons . . . .'" Boetius writing in the latter part of the fifth century, though skeptical as to the nature of the toad-stone, gives many interesting theories concerning it. Lyly states that "the foule toad hath a faire stone in its head" while contemporary writers make reference to the same subject. Perhaps the most interesting treatises on this subject are those of Browne and of Topsell. The first writer after a full discussion of the beliefs pro and con, decides that "we must with circumspection receive those stones which commonly bear this name, much less believe the traditions that in envy to mankind they are cast out or swallowed down by the toad." He shows how many a venerable fossil fish tooth probably had been "palmed off" upon unsuspecting purchasers and concludes that while a bona fide Bufonite might be possible, the probability of the occurrence was very doubtful. Topsell states "that there be many that ware these stones in Ringes, beeing verily perswaded that they keep them from all manner of grypings and paines of the belly" and describes carefully how a toad-stone was said to be obtained, a process, by the way, involving much strategy. The actual fact of the occurrence of the toad-stone is handled in the following very diplomatic manner: "Therefore they beeing in sundry opinions, the hearing whereof might confound the reader, I will refer him for his satisfaction unto a toade which hee may easily every day kill; and if the stone be found there in substance then is the question at an end." Doubtless had the ancients applied this very simple test, much controversy and brain-fag could have been avoided.

The toad had an important place in the pharmacopoeia of the early days. Pliny states that "it yeelds many good things medicinable." Other writers bear testimony to the sovereign power of a dried toad in preventing and curing bleeding from the nose. It is stated that English noblemen used dried toads bound upon the knee as a potent remedy for gout. While the medical practitioners thus found the toad to be of service in curing the ills of the flesh, others versed in magic art were supposed to find in it the acme of venom with which to complete their mysterious preparations.

"Toad that under the cold Stone
Days and Nights has, thirty one,
Swelter'd venom sleeping got,
Boil thou, first ith' charmed' Pot."

Of the fables concerning the toad and spider and their alleged antipathy, so common in the early writings, the ridiculous story related by Erasmus will serve as a fair sample. A worthy monk, so runs the story, was once found by his brethren fast asleep with a large toad seated upon his face. Believing the sleeping brother to be in imminent peril, they at once sought means to deliver him, yet none dared touch the toad. A large spider was seen at the window near by; the sleeping monk was carried to the window when the spider descended and speedily dispatched the toad. Browne, after discussing such absurd fictions, frankly states: "But what we have observed herein, we cannot in reason conceal; who having in a glass included a toad with several spiders, we beheld the spiders, without resistance to sit upon his head and pass over all his body; which at last upon advantage he swallowed down, and that in a few hours unto the number of seven."

So much for ancient European beliefs. Since our toads are congeneric with those of Europe and resemble them closely, and since such superstitions were current at the time of the colonization of our country, it is easy to see how these beliefs were readily applied by the early settlers to our native batrachians Such creations of the imagination seem at the present day scarcely more than ludicrous, yet carefully cherished in an occasional New England family we find fancies equally absurd, such as that touching toads will produce warts on the hands; that killing toads will produce bloody milk in cows; that a toad's breath will cause convulsions in children; that a toad in a newly dug well will ensure a good and unfailing supply of water, or in a new-made cellar will bring prosperity to the household, etc., etc.

LIFE HISTORY AND HABITS.

In this region the toad usually emerges from its hibernating quarters during the month of April. Cold weather retards its movements, but on warm days at this season the toads may be found on their way to the ponds and stagnant pools, where a little later the characteristic shrill cry may be heard throughout the day and evening. Mating is commenced as soon as the water is reached, or even before, and in a few days the long slimy "ropes" of eggs deposited by the female may be found in the pools. The eggs are nearly black in color and rapidly increase in size. In two weeks the young tadpoles are clearly outlined and in three or four weeks the eggs hatch. The vegetable detritus of the pond bottoms and the slime and algae attached to sticks, plants, etc., seem to be the common food of the tadpole. Bosc is of the opinion that entomostraca, infusoria and water insects are also devoured. Warm weather favors the growth of the tadpoles and usually by July 1-15 the young toads are fully developed, leave the water and spread over the fields. At this stage they are exceedingly sensitive to heat and secrete themselves under leaves, rubbish, stones, etc., during the day; but let a vigorous shower descend and the transformation is magical. The walks, roads and gardens at once become peopled with myriads of these thirsty, leaping creatures, and their sudden appearance has led to the popular belief that they "rain down". It is fortunate for them that when young they are unable to endure solar heat, otherwise large numbers would probably be destroyed by the birds which are active during the day; doubtless many are killed by the predaceous birds and mammals which prowl by night.

Authorities differ as to the age at which the toad begins to reproduce, but probably this does not take place before the fourth year. The number of eggs laid by the adult female is remarkable. From an average-sized female, captured during the spawning season, I removed 1,279 ova and as she had already commenced laying, this figure does not represent her total number of eggs.

The longevity of the toad has been a fruitful theme of controversy. Volumes might be filled with the stories of those found imbedded in rocks, masonry or trees, yet nearly all these statements lack that careful detail of attendant circumstances which is so necessary to remove doubt in the mind of the reader. Of interest in this connection are the experiments of Mr. Herrisant who in 1777 placed three toads in sealed boxes of plaster and deposited them in

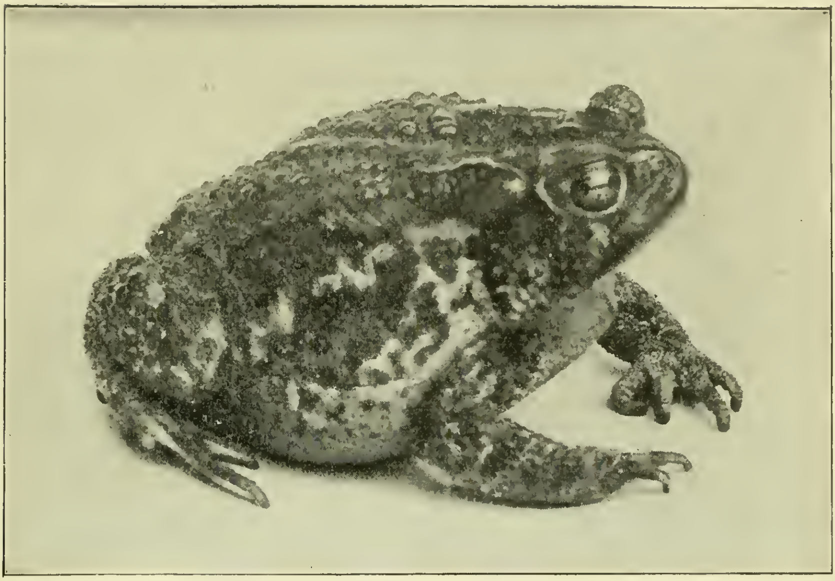


FIG. 1. The American Toad, *Bufo lentiginosus americanus (LeC.)*

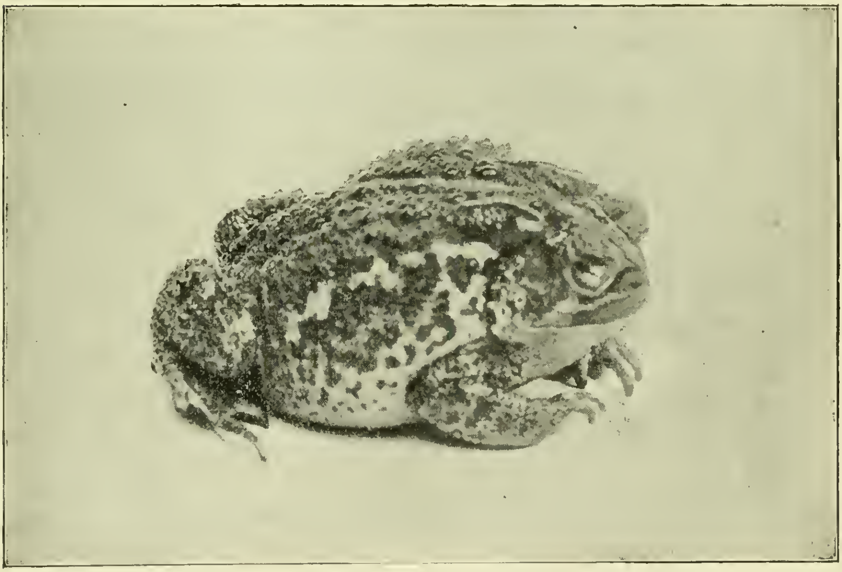


FIG. 2. Toad in Hibernating Position.

the archives of the French Academy of Sciences. Upon opening the boxes at the end of eighteen months, two of the toads were found to be alive. Dr. Edwards in 1817 repeated these experiments and found that when the boxes were submerged in water the death of the toads speedily resulted. Buckland investigated the matter quite thoroughly by preparing cavities in limestone and sandstone and confining in them toads of various sizes. These stone chambers were then buried three feet deep in a garden. At the end of thirteen months all the toads in sandstone were dead and a like fate overtook those in limestone before the end of two years. These experiments show that it is possible for the toad to exist for a limited time without food, but throw a shadow of improbability upon the stories of those found in rocks, trees, etc.

There are authentic European records of a toad that lived to be thirty-six years old and then was accidentally killed; it seems probable that our American species may be equally long lived, but unfortunately this is a point that apparently has never been noted in our zoölogical literature. Nearly every old New England homestead has one or more semi-domesticated toads whose age can only be conjectured. The writer has sought in different parts of the State, among families who have long resided on the places they now occupy, for some accurate information on this subject, and from a mass of statements, given in many cases with strong corroboratory details, there may be taken apparently veracious records of two toads that have occupied dooryards in two different towns for twelve and twenty-three years respectively. The histories of these toads have been given me by people of unquestionable veracity, yet I hesitate to present the records as facts, since from the evidence offered I cannot feel positive that the identity of the toad in either case has remained unchanged.* There can be but little doubt that toads live to a considerably greater age than is supposed and we may hazard the opinion that many of them reach an age of at least ten or fifteen years.

When suddenly disturbed or roughly handled, the toad ejects a colorless fluid from the anus and a milky liquid from the skin. This habit is probably the basis for the belief that the toad is venomous. The secretion of the skin glands is harmless when applied to the hands, but it evidently possesses acrid properties, since when toads are bitten by dogs or cats, the latter usually have a copious flow of saliva, show signs of discomfort and in some cases coming under the observation of the writer, have manifested considerable distress. That this fluid is not objectionable to all animals is apparent from the fact that many hawks, owls, etc., include the toad in their bill of fare. Brocchi found that when injected into a blood vessel of a pigeon this fluid caused the death of the bird.

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* Since writing the above, Mr. F. H. Mosher, who has frequently assisted me in various experiments on the gypsy moth and whose accuracy as an observer cannot be questioned, informs me that he has positive knowledge of a large toad that has occupied a dooryard for at least eight years.

During the summer months we often find toads of much fresher and brighter colors than their fellows ; this is due to a molting of the skin, a process that takes place four or five times each year. The toad is reported to swallow the molted skin, but this I never have been able to witness. Previous to, and for a few hours after molting, the toad remains quiet in some dark or sheltered place.

On the approach of cool weather, sometimes as early as the first of September, toads begin to seek winter quarters. These they find in cellars, under buildings, rocks, leaves or rubbish, and in places where the action of frost will not be felt. Cold benumbs them, but does not kill. In March, 1895, the writer found toads under leaves in the Middlesex Fells when the thermometer stood at about 20° Fh. These animals were apparently frozen, but after being held in the hand for some time, began to show signs of life. In his work on Reptiles and Birds, Figuier states that these animals freeze without being killed, while Buffon is authority for the statement that in the vicinity of Hudson Bay, frogs are frozen hard during the winter, but revive in the spring. A distinction should be made between the hibernation of mammals where the bodily functions though depressed are still performed and that of amphibians, reptiles, insects, etc., where these functions are apparently entirely suspended. Toads do not hibernate singly as a rule and it is not an uncommon thing to find in the winter or spring a dozen or more closely packed together under a rock or board or in some other sheltered spot.

FEEDING HABITS.

The toad cannot endure high temperatures and hence it is not commonly seen in the day time. Properly speaking, it is a nocturnal animal, though it sometimes ventures out during the day when tempted by an abundance of food in its immediate vicinity or, more commonly, when the air is full of moisture. It is an animal that suffers from excessive transpiration of moisture from the body, the skin being thin and readily permitting the passage of water. That water is probably taken in through the skin is apparent from the sudden appearance of toads during showers or when lawns are being sprinkled.

The toad does not take dead or motionless food. Only living and moving insects, centipedes, etc., are devoured. I have repeatedly seen proof of this fact. Cut worms or other larvae disturbed by the hopping of the batrachian are safe so long as they remain curled up; but immediately they commence to travel they are captured. The toad's tongue (Plate II. figs. 1, 2,), its only organ for seizing food, is soft, extensile, attached in front, but free behind, and is covered with a glutinous substance which adheres firmly to the food seized. So rapid is the motion of this weapon that a careful watch is necessary in order to see the animal feed. The writer once confined for study a large toad in a shaded out-of-door box filled with damp earth. To provide suitable and sufficient food for it was quite a task until an entirely satisfactory expedient suggested itself. A hard bread-crust was soaked in molasses and placed in the cage. Bees, wasps, ants, flies and beetles came to this bait and it was most interesting to watch the toad seize the flying insects, often before they had alighted on the bread. Stinging insects, bees, wasps, etc., when swallowed by the toad apparently produced uncomfortable sensations for a short time. Fish-worms when captured by the toad often prove too much to be swallowed at once and when this is the case the fore-limbs are brought into use to force the unfortunate worm into the capacious gullet of its captor.

At night, soon after sundown, or even before on cool evenings, the toad emerges from its shelter and slowly hops about in search of food. Something of a regular beat is covered by these animals whose sense of locality is quite strong. In the country this includes forays along roadsides, into gardens and cultivated fields, and wherever insect food is abundant and grass or other thick herbage does not prevent locomotion. In cities and suburban villages the lawns, walks and particularly the spots beneath electric lamps are favorite hunting grounds. At Amherst, Massachusetts, the writer once counted eight large well-fed toads seated under an arc light and actively engaged in devouring the insects, which, deprived of wings, fell from the lamp above. Dr. Charles Burleigh, a prominent physician of Malden, Massachusetts, and a close observer in the field of natural science, informs me that a colony of some half-dozen toads has for some time occupied the sheltered space under the piazza of his house and that each summer night at about eight o'clock, they sally forth down the walk, cross the street and take up their stations under an arc lamp that is located about three rods from the house. Here they remain and feed upon the fallen insects until the electric current is turned off, when they return to their accustomed shelter.

During the past two years the writer has made many observations on toads feeding under natural conditions at all hours of the night. From these observations and from stomach examinations it appears that the toad feeds continuously throughout the night, except when food is unusually abundant. In twenty-four hours the amount of food consumed is equal in bulk to about four times the stomach capacity. In other words, the toad's stomach is practically filled and emptied four times in twenty-four hours. This I have verified by studies on toads confined in cages.

THE FOOD OF THE TOAD.

To establish the economic status of an insectivorous animal two methods of procedure are available: First, observation of the feeding habits; second, stomach examination. Field observations are of high importance as affording correlative and supplementary evidence, but stomach examinations, as Professor Beal has so aptly put it, constitute "the court of final appeal." Good eyesight, patience and strategy will enable one to watch the feeding of insectivorous animals, but identification of insects cannot be made at long range and the material devoured, must be available for careful study. A "slaughter of the innocents" can never be approached with feelings other than those of regret, yet there are occasions where the end justifies the means and this would seem to be the case where investigations are being made in the field of nature with a view of contributing to the sum total of human knowledge. In the investigations on the food of the toad, stomachs were obtained from different parts of the state and more particularly from different kinds of localities, *i. e.*, fields, gardens, marshes, plains, hills, woodlands, etc., during every month of the season of the toad's activity. In this manner one hundred and forty-nine stomachs were collected and examined. This number, the writer fully appreciates, is too small to show the exact status of the toad in this region, yet it is sufficient to afford data for some general conclusions. In nearly every case the stomachs were examined while fresh; a small number were preserved in formalin for a few weeks before examination.

In making the examinations the stomachs were split along the outer curvature and the contents washed into a glass dish. The material thus obtained was separated into groups and the insects or parts of insects and other animals were identified by comparison with named specimens. The relative per cent by bulk of each class of food was then estimated and the data as to character and amount were noted.

NUMBER OF STOMACHS EXAMINED.

April.	May.	June.	July.	August.	September.	Total.
7	30	66	29	10	7	149

CHARACTER OF STOMACH CONTENTS AND PERCENTAGE OF EACH FOOD ELEMENT.

Unidentified material	5	Carabids,	8	
Gravel,	1	Scarabaeids,	6	
Vegetable detritus,	1	Click beetles,	5	
Worms,	1	Weevils,	5	
Snails,	1	Chrysomelids,	1	
Sow bugs,	2	Carrion Beetles,	1	
Myriapods,	10	Miscellaneous beetles,	1	
Spiders,	2	Total Beetles,		27
Grasshoppers and crickets,	3	Cut worms,	16	
Ants,	19	Tent caterpillars,	9	
		Miscellaneous larvae,	3	
	Total	Cut worms, caterpillars, etc.,		28

The contents of the stomachs examined may be readily separated into three groups, animal, mineral and vegetable, but the presence of substances other than of an animal nature is probably more or less accidental.

VEGETABLE MATTER. Of the total contents of one hundred and forty-nine stomachs, vegetable material formed less than one per cent and from its character appears to have been taken by accident and cannot be properly considered as food. Since the toad takes the greater part of its food from the ground by means of its large, fleshy tongue, nothing can be more natural than that a small quantity of vegetable detritus should be swept into the mouth along with the insects on which the animal feeds. The most common vegetable substance found in the stomachs is grass, both dry and fresh. Bits of rotten wood, broken acorn shells, seeds of the linden (*Tilea americana*) and maple (*Acer saccharinum*) and bits of apple parings have also been detected. All these vegetable substances were usually associated with a large quantity of ants and other terrestrial insects.

Mineral Matter. The mineral matter found in the stomachs forms slightly more than one per cent of the total contents and consists of gravel, sand, and in a few cases, coal ashes. When a large piece of gravel is swallowed it is regurgitated: this I have proven by experiments on toads in confinement. Otherwise the gravel passes through the alimentary canal and may be found in the castings. Since the toad does not masticate its food, but depends on the stomach for the whole process of trituration it is probable that the gravel when present assists in grinding the strongly chitinized bodies of beetles, etc., yet in the majority of the toads examined there was no gravel present in the alimentary canal although many of the stomachs contained finely ground beetles. A proper inference from the above is that gravel is not essential to digestion in the toad and the writer inclines to the opinion that, as in the case of vegetable matter, the presence of gravel in the stomachs is the result of accident rather than of design. May we not have here a hint as to the origin of the gravel eating habit in birds?

Animal Matter. Animal substances constitute ninety-eight per cent of the total food for the season. They may be readily separated into worms, molluscs, crustaceans, myriapods, spiders and insects, the latter group furnishing by far the greatest percentage. It has been found impossible to recognize sufficiently to refer to its proper class, about five per cent of the animal food, hence no farther reference will be made to it.

Vermes. Earth-worms, *Lumbricus* sp?, constitute one per cent of the whole food. They were found in fourteen stomachs, chiefly those of toads killed soon after showers. Doubtless the rains drove the worms to the surface and thus rendered them easy victims for the toads. Earth-worms in place, as Darwin has so ably shown, are highly beneficial; out of place, as any greenhouse owner can testify, they are decidly obnoxious and often injurious.

Mollusca. Molluscs furnish scarcely one per cent of the total stomach contents, yet it was a pleasure to recognize the common "slug" of the hothouse and garden, *Limax* sp?, in several stomachs. Toads taken along the shore at Revere, Massachusetts, yielded several *Melampus bidentatus* Say.* while *Helix* sp? occurred in a few stomachs. An interesting point in this connection is the fact that the shells of these animals were more or less dissolved by the digestive fluids. Shells from the lower part of the stomachs were almost entirely dissolved.

Crustacea. Members of the sub-order Isopoda commonly called "sow bugs." *Oniscus* sp., *Porcellio* sp., occurred in nearly all the stomachs, yet formed but two per cent of the total food. The greatest number were found in September when they constituted six per cent of the food for the month. These creatures are a great nuisance in greenhouses where they eat the roots of orchids, violets, pansies, young roses and other plants. In destroying these crustacea the toad renders a distinct service to gardeners.

Myriapoda. Myriapods form a constant article of diet for the toad. Species of the genus *Julus* were present in the majority of the stomachs examined, the largest number found in a single stomach being seventy-seven. These creatures form ten per cent of the food for the season. They are commonly injurious to low growing fruits and garden crops, as a glance through the literature of economic entomology will amply prove. Of the damage to potato crops occasionally resulting from these myriapods, Prof. J. A. Lintner has given a most excellent account in his third report on the Insects of New York, page 133. Prof. C. H. Fernald informs me that a species of *Julus* often attacks newly planted potatoes. In greenhouses they feed upon plants in beds and destroy the roots of lettuce, geraniums, orchids, etc.

Arachnida. Spiders occur in the stomachs of toads in all months, but form only two per cent of the total food. This destruction of spiders should be counted against the toad, since they feed on flies, small moths and other insects, many of which are obnoxious or injurious to man. The damage resulting from the destruction of this small quantity of spiders, however, may be counterbalanced by the benefit from the killing of injurious "sow bugs" and snails.

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* Kindly identified for me by Mr. John Ritchie, Jr., Boston, Massachusetts.

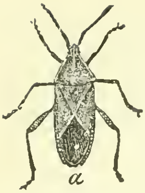

FIG. 1. The Squash Bug, *Anasa tristis.*

Insecta. We now come to the most interesting phase of the whole question of the economic value of the toad, a consideration of the insect food. Insects constitute seventy-seven per cent of the total food for the season and the natural orders represented contribute the following percentages : Orthoptera, three per cent ; Hymenoptera, nineteen per cent ; Coleoptera, twenty-seven per cent ; Lepidoptera, twenty-eight per cent. A few Hemiptera and Diptera were found, but these taken together do not form one per cent of the whole food.

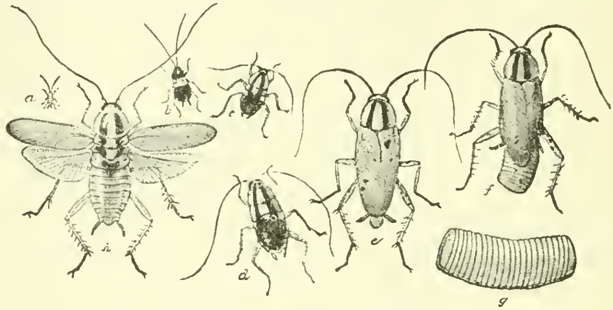

FIG. 2. The German Roach, *Blatta germanica.*

Orthoptera were found in the stomachs throughout the season, reaching their maximum in September when they formed eight per cent of the food for the month. The common cricket, *Gryllus luctuosus* Serv., and the cockroach, *Blatta germanica* Fab., were frequently recognized in the stomach contents. The value of the toad as a destroyer of roaches has been commented on by Mr. W. W. Meech in Insect Life, Vol. 1, page 341, where it is stated that the toad " will clear your room of cockroaches over night just as he will your garden of the vilest of your insect foes." The species identified are more or less injurious and the three per cent of Orthoptera consumed by the toad should be placed to its credit.

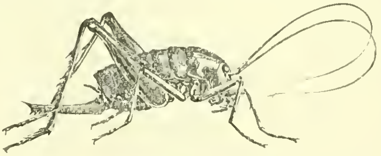

FIG. 3. The Wingless Grasshopper, *Ceuthophilus maculatus.*

Aside from ants, two humble bees, one *Augochlora* sp., eight wasps and two ichneumons comprise the representatives of the Hymenoptera recognized in the stomachs examined. Ants are the most constant food-element found in the stomachs and constitute nineteen per cent of the total food for the season. The highest percentage of these insects was recorded in May when ants were found in twenty-one of the thirty stomachs examined, formed thirty-three per cent of their contents and twenty-three per cent of the food for that month. The toad is a well known ant-eater and one occasionally sees it even at midday, emerging from its hiding place to feed upon a passing swarm. Opinions differ as to the economic value of ants. They are such models of industry and show such a high grade of intelligence that some authorities are disposed to regard their short-comings with a lenient eye. Concerning the value of the species of *Camponotus* and *Formica* the writer sought the opinion of Prof. L. O. Howard and received the following reply: "I have talked with Mr. Pergande, who has long studied our ants, as you doubtless know, and I am able to give you the following information: On the whole the character of the common black ants of the genera *Camponotus* and *Formica* is negative. They feed upon dead insects and, to some little extent, on living insects, and on honey dew, whether secreted by plant lice, bark lice, galls, or by the nectar glands of plants themselves. The number of injurious insects killed, on the whole, is very small. They do not transport plant lice and care for them to any extent: that is to say, they are not anything like as injurious in this way as are ants of other genera. They are occasionally somewhat annoying in houses, but do not form their nests in the timber of buildings unless it is rather decayed."

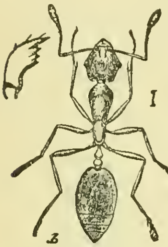

Fig. 4. The Red Ant, *Monomorium pharaonis.*

The chief service rendered by ants is the killing of a few injurious insects. On the other hand they infest lawns and houses and render themselves generally obnoxious around the dwellings of man. During the past summer I have observed somewhat closely the habits of the species most frequently found in the stomachs. *Camponotus pennsylvanicus* DeG. and have seen them destroy but few living insects while they did destroy a large number of moths on spreading boards and committed many other depredations around our Malden laboratory. In the vicinity of Boston where many buildings are supported by piles more or less decayed, this species is a common and very annoying household pest. I have discussed the economic value of these ants with Professor Fernald and he agrees with me in the conclusion that so far as the toad destroys these insects it should be considered a beneficial animal.

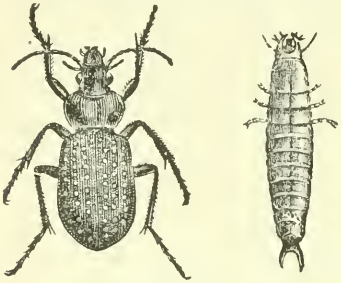

FIG. 5. A "Cut Worm Killer", *Calosoma calidum.*

Coleoptera form twenty-seven per cent of the total food and are chiefly represented by Carabids, Scarabaeids, Elaterids and weevils. Carabidae were found to be a constant article of food throughout the season and form eight per cent of the total food. *Calosoma calidum* Fab. was found in six stomachs and in one case a specimen of this insect was taken alive from the stomach of a toad captured late at night. The insect lived for about twelve hours afterward. The per cent of Carabidae consumed is nearly constant throughout the season, the maximum being nine per cent for the month of June. The destruction of insects of such well known predaceous habits counts strongly against the toad. The larger Carabidae are especial enemies of terrestrial lepidopterous larvae and render much valuable service by destroying cutworms.

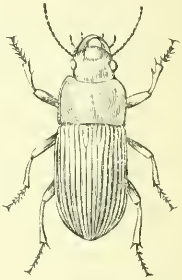

FIG. 6. *Harpalus caliginosus.*

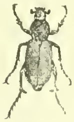

FIG. 7. The Rose Chafer, *Macrodactylus subspinosus.*

Against the killing of these beneficial insects may be reckoned the consumption of a large number of Scarabaeids, Elaterids and weevils. The Scarabaeidae, of which family the May-beetle and Rose-chafer are typical representatives, form six per cent of the whole food. These insects in their larval stage feed largely upon the roots of grass and, as in the case of the May beetle, frequently cause great damage to grass lands and pastures. In the mature form some of them, like the Rose chafer, devour the blossoms and leaves of ornamental plants and cultivated crops.

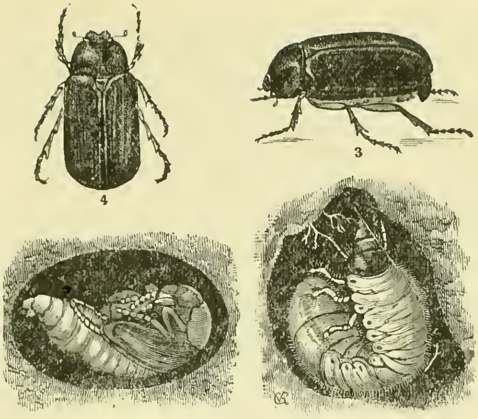

FIG. 8. The May Beetle. *Lachnosterna fusca.*

The frequent damage to the potato crop resulting from the ravages of the white grub is a matter of common knowledge. *Lachnosterna fusca* Fröh. was found in eighteen stomachs, one of which contained four of these beetles. *Macrodactylus subspinosus* Fab. and *Euphoria inda* Linn. were of frequent occurrence in the stomachs. Elateridae form five per cent of the total food. These "click beetles" being the parents of wire-worms should be reckoned as injurious species. Nearly every farmer in Massachusetts has suffered to a greater or less extent from having his sprouting grain or potatoes partially destroyed by wire worms. Cabbages, lettuce, and potato vines are frequently damaged by them. Five per cent of the total food was found to be composed of weevils, insects of generally injurious character. The plum curculio was found in two stomachs while some of the other species recognized are of importance as being borers in standing timber and shade trees.

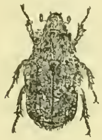

FIG. 9. The Indian Cetonia, *Euphoria inda.*

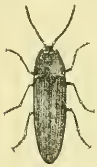

FIG. 10. A Click beetle.

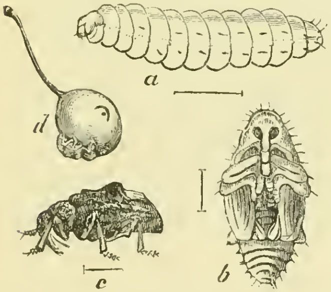

FIG. 11. The Plum Curculio, *Conotrachelus nenuphar.*

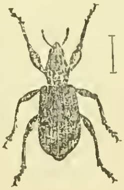

FIG. 12. *Pandeletejus hilaris.*

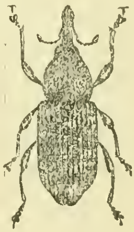

FIG. 13. *Hylobius pales.*

Chrysomelids, carrion beetles and miscellaneous beetles form one per cent each of the total stomach contents. The Chrysomelidae as a whole are leaf-eaters and include such injurious species as the potato beetle and striped cucumber beetle, both of which were identified in the stomachs. The carrion beetles, while of no great economic importance are sometimes indirectly helpful to man since they contribute somewhat to his comfort by seeking out and burying carrion that might otherwise be offensive. For this reason they may be considered as beneficial insects and their destruction as counting slightly against the toad. The miscellaneous beetles include scattering representatives of many families and, aside from a few Coccinellids, are of no particular importance from an economic standpoint.

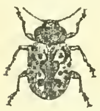

FIG. 14. *Chrysomela scalaris.*

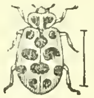

FIG. 15. *Megilla maculata.*

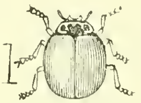

FIG. 16. *Coccinella sanguinea.*

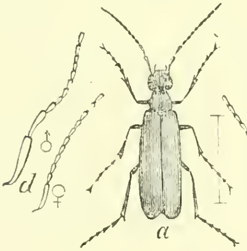

FIG. 17.

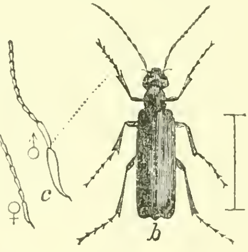

FIG. 18.

Blister beetles.

Of the Lepidoptera, but few mature insects were found in the stomachs examined. One crambid and four noctuid moths represent the total imagoes. Lepidopterous larvae, however, form the chief food (twenty-eight per cent), for the whole season. They may be divided into three groups: cut worms, sixteen per cent; tent caterpillars, nine per cent; and miscellaneous larvae, three per cent. Among the latter such injurious species as *Euvanessa antiopa*, *Porthetria dispar*, *Pyrophila pyramidoides* and *Paleacrita vernata* were often present. It would seem as if the armor of the Vanessa larva would serve as a protection against the toad, but the stomach that is able to receive and peacefully digest "yellow jacket" wasps does not flinch before the spiny covering of this caterpillar. Six full grown larvae of this species were taken from a single stomach.

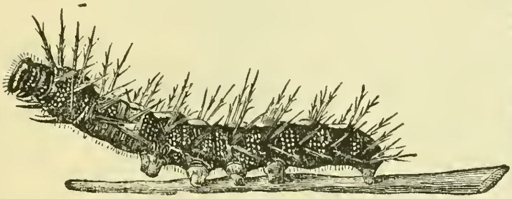

FIG. 19. Larva of *Euranessa antiopa.*

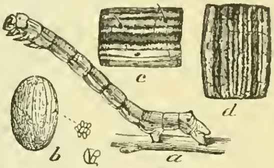

FIG. 20. Spring Cankerworm, *Paleacrita vernata.*

In eastern Massachusetts where brushland is infested by the gypsy moth, the toad renders considerable service in destroying the caterpillars of this highly injurious insect. The stomachs of three toads captured in such an infested spot contained respectively seven, fifteen and sixty-five gypsy moth larvae.* Contrary to the usual habits of the animal, these toads were feeding at midday and on a high, dry hillside, doubtless being attracted from their accustomed haunts by the abundance of caterpillars.

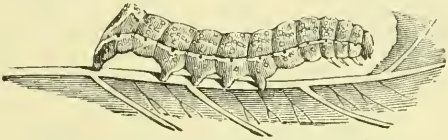

FIG. 21. Larva of *Pyrophila pyramidoides.*

Tent caterpillars were found only in stomachs taken in May and June. In the former month they formed eighteen per cent of the food. At the time when these insects are fully grown and are crawling over the ground in search of a suitable place for pupation, they fall an easy prey to the toad. The remains of thirty-seven full grown tent caterpillars were taken from a single stomach while many others contained from fifteen to twenty. Since this insect is an apple tree pest of the first rank, the good work of the toad in this connection is entitled to high commendation.

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*The Gypsy Moth, Forbush-Fernald, 1896 p. 404.

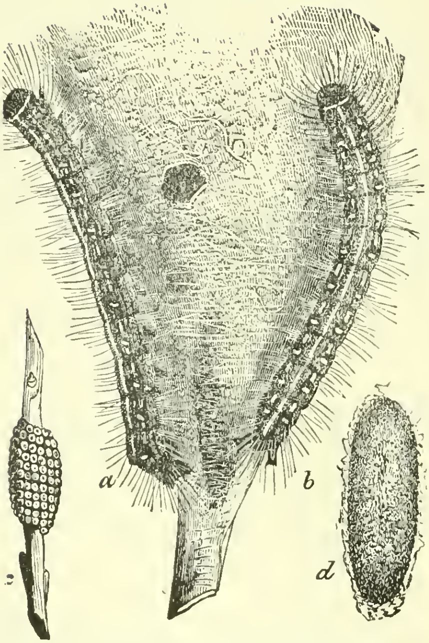

FIG. 22. Tent caterpillar, *Clisiocampa americana*.

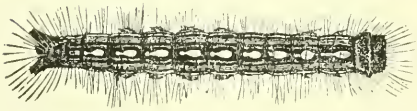

FIG. 23. Forest Tent Caterpillar, *Clisiocampa disstria*.

The damage caused by cut worms to lettuce, cabbage, cucumbers, peas, beans and in fact to nearly all young garden crops is a matter only too well understood by farmers and it is a pleasure to record that sixteen per cent of the total food of the toad is composed of these nocturnal destroyers of vegetation. These insects remain in concealment during the day and feed by night, hence it is to nocturnal animals like the toad that the farmer must look for a natural check upon their ravages.

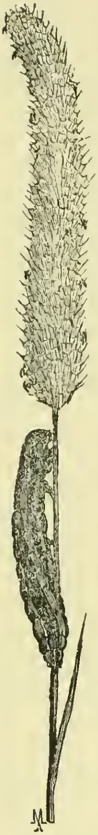

FIG. 24. The Army worm, *Leucania unipuncta.*

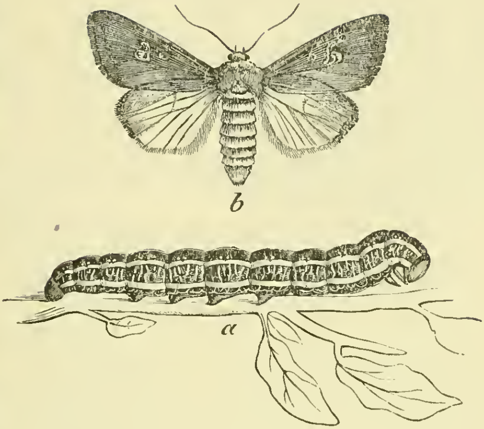

FIG. 25. A Cabbage pest, *Mamestra picta.*

During the army worm outbreak of the past year, the writer had occasion to observe the toad in the role of a destroyer of this insect. At Hingham, Massachusetts, two toads were observed busily engaged in feeding upon a migrating "army" of these larvae while in all the devastated fields toads were very abundant. Dissections of three toads taken in infested fields revealed the presence of nine, eleven and fifty-five army worms in their respective stomachs.* When one considers the annoyance and damage caused by cut worms, the value of the toad is at once apparent. These insects are of such habits that their destruction is a matter attended with considerable difficulty and it is as a destroyer of cut worms that the toad renders the most important service to the agriculturist.

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*Mass. Crop Report, July 1896, p. 35.

The evidence in regard to the economic value of the toad may be thus summarized :—

1. It destroys carabid beetles, insects of a highly beneficial character.

2. It devours an occasional ichneumon fly and "lady bird", beneficial insects.

3. It feeds to a small extent on spiders, generally considered to be valuable as insect destroyers.

4. It devours carrion beetles, insects indirectly helpful to man.

1. It feeds on worms, snails and sow bugs, common greenhouse pests.

2. It devours a large number of myriapods which damage greenhouse and garden plants.

3. It feeds to some extent on grasshoppers and crickets.

4. It destroys large quantities of ants, insects often injurious and usually obnoxious.

5. It consumes a considerable quantity of May beetles, Rose chafers, "click beetles", potato beetles, cucumber beetles and weevils, all more or less injurious to crops of various kinds.

6. It feeds on tent caterpillars, gypsy moths and other fruit tree pests.

7. It is a prime destroyer of cut worms and army worms, common pests which often cause great damage.

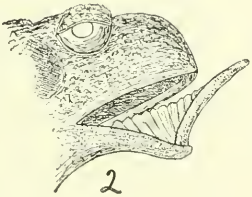
To recapitulate, eleven per cent of the toad's food is composed of insects and spiders beneficial or indirectly helpful to man ; eighty-per cent, of insects and other animals directly injurious to cultivated crops or in other ways obnoxious to man. Farther comment upon the valuable services of the toad would seem unnecessary.

LIST OF INSECTS FOUND IN THE STOMACHS EXAMINED.

The following list includes a part of the species found in the stomachs. In many cases, particularly with lepidopterous larvae, specific or even generic identifications could only be made of a limited proportion of the whole number of insects present. Since the toad swallows its food intact, a large part of the hard-bodied insects could be identified.

PLATE II.

1



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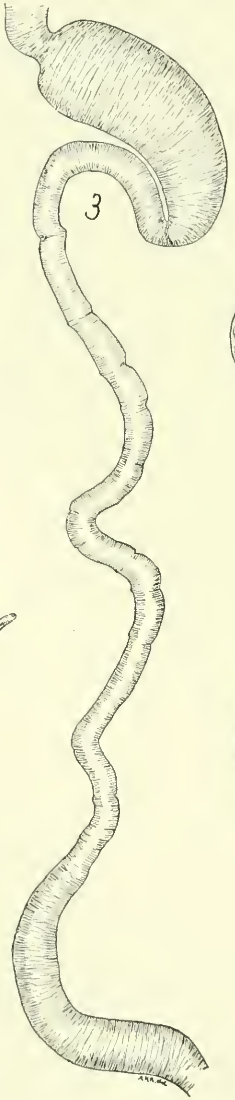

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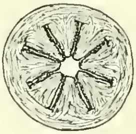

4

5

HYMENOPTERA.

Bombus vagans Smith.
Augochlora sp?
Vespa diabolica Sauss.
Vespa vulgaris Linn.
Camponotus pennsylvanicus DeG.
Formica rufa Linn.
Formica subsericea Say.
Monomorium pharaonis Linn.
Ichneumon funestus Cress.
Ichneumon sp.

COLEOPTERA.

Cicindela 6-guttata Fab.
**Calosoma calidum* Fab.
Pterostichus sp?
Amara sp?
Platynus sp?
Dromius sp?
Pinacodera sp?
Harpalus sp?
Anisodactylus sp?
Necrophorus tomentosus Web.
Silpha americana Linn.
Staphylinus maculosus Grav.
" *cinnamopterus* Grav.
Ocypus ater Grav.
Megilla maculata DeG.
Coccinella trifasciata Linn.
" *sanguinea* Linn.
Adalia bipunctata Linn.
Hister foedatus Lec.
Melanotus fissilis Say.
" *communis* Gyll.
" *sagittarius* Lec.
Asaphes memnonius Hbst.
Dicerca divaricata Say.
Geotrupes splendidus Fab.
Serica vespertina Gyll.
Macrodactylus subspinosus Fab.
Lachnosterna fusca Fröh.
Aphonus tridentatus Say.
Euphoria inda Linn.
Phymatodes variabilis Fab.
Doryphora 10-lineata Say.
Chrysomela similis Rog.
" *spiraeae* Say.
Diabrotica vittata Fab.
Tenebrio molitor Linn.
" *larva* sp?
Helops micans Fab.
Epicauta cinerea Forst.
Otiorhynchus sulcatus Fab.
" *ovatus* Linn.
Pandeletejus hilaris Hbst.
Ithycerus noveboracensis Forst.
Hylobius pales Hbst.
Conotrachelus nenuphar Hbst.
Cryptorhynchus lapathi Linn.

LEPIDOPTERA (larvae).

Euvanessa antiopa Linn.
Clisiocampa americana Harr.
" *disstria* Hbn.
Arsilonche albovenosa Goetze.
Rhynchagrotis alternata Grt.
Agrotis sp?
Noctua c-nigrum Linn.
Noctua clandestina Harr.
Carneades sp?
Mamestra picta Harr.
Nephelodes minians Gn.
Leucania unipuncta Haw.
Pyrophila pyramidoides Gn.
Paleacrita vernata Pack.

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*For the identification of the Carabidae I am indebted to the courtesy of Mr. A. F. Burgess.

HEMIPTERA.

Euschistus fissilis Uhl.
Anasa tristis DeG.
Ceresa sp?

ORTHOPTERA.

Gryllus luctuosus Serv.
Ceuthophilus maculatus Harr.
Xiphidium brevipenne Scud.
Blatta germanica Fab.
Pezotettix sp?
Melanoplus femoratus Burm.
" *femur-rubrum* DeG.

DIGESTION: AMOUNT OF FOOD.

The digestive process in the toad is one of trituration and solution. The muscular stomach grinds the food while the acid digestive fluids soften and render assimilable the various food elements. Samples of the digestive fluids of the toad submitted for analysis to Mr. F. J. Smith, Chemist to the Gypsy Moth Committee, were found by him to be rich in hydrochloric acid and to contain a small amount of phosphoric acid. That the digestive process is ordinarily a continuous one is shown by the fact that in a majority of the stomachs examined the food at the pylorus was finely ground and nearly digested, while that near the cardiac orifice was intact and, to all appearances, but recently swallowed.

The quantity of food that can be accommodated in the stomach of the toad is remarkable. As stated on previous pages, the remains of seventy-seven myriapods were found in a single stomach, fifty-five army worms in another, sixty-five gypsy moth caterpillars in a third, and thirty-seven tent caterpillars in a fourth. In these cases, however, but one kind of food was present and the toads were above the usual size. On one occasion Mr. J. E. Wilcox, a former employee of the Gypsy Moth Committee, fed to a toad of medium size twenty-four fourth-molt gypsy moth larvae, all of which were swallowed in less than ten minutes. Mr. F. H. Mosher once fed a toad upon a quantity of full-grown celery worms (*Papilio asterias*) and in three hours' time the animal had consumed between thirty and thirty-five. In this case the toad rested at intervals of about twenty minutes each between the times of feeding.

In looking over my notes on the stomach examinations, I find a record of a toad killed at 9 : 00 P. M., May 11, 1896, whose stomach contents represent a fair average of the whole number of stomachs examined, both for variety and quantity of food elements. In the stomach contents were recognized :—

9 ants (*Camponotus pennsylvanicus*).
6 cutworms.
5 myriapods (*Julus* sp?).
6 sow bugs (*Porcellio* sp?).
1 weevil (*Hylobius pales*).
1 carabid beetle (*Pterostichus* sp?).

As previously stated, in twenty-four hours the toad consumes an amount of food equal to that required to fill the stomach four times. A toad feeding at this rate upon the same kinds of food and in the same proportions as in the case cited would devour in the three months of May, June, and July the following quantities of food: 3,312 ants, 2,208 cut worms, 1,840 myriapods, 2,208 sow bugs, 368 weevils and 368 carabids. Or in other words, in the three months a toad would consume 368 beneficial insects and 9,936 injurious insects, myriapods, etc.

To properly estimate the financial equivalent of the damage and annoyance that might be caused by these insects would be a difficult and unsatisfactory task, since data for the calculation must be of an arbitrary nature. If we confine our attention to but one element of the food, the cutworms, we reach some very interesting results. If we assume that ten per cent of these insects, eaten by a toad feeding under the given conditions, would have been killed by the carabid beetles which the toad also devours, we still have the destruction of 1,988 cutworms to place to the toad's credit. If the damage the cut worms would have caused be estimated at one cent per worm, a figure which gardeners and tobacco growers will probably consider ridiculously low, we find that in one season a toad might destroy cutworms which otherwise would have damaged crops to the extent of $19.88.

HOW THE TOAD MAY BE MADE USEFUL.

To all agriculturists the toad renders conspicuous service, but gardeners and greenhouse owners may make this animal of especial value. Every gardener should aim to keep a colony of toads among his growing crops and the practice of collecting and transferring them to the gardens is a commendable one. While the sense of locality is strong in this batrachian and it will often return over considerable distances to its original haunts, yet it may be induced to remain in new quarters if there is a sufficient food supply. Many farmers provide toads with artificial shelters made by digging shallow holes in the ground and partially covering them with a bit of board or flat stone. In such places toads will often remain for many days, sallying forth at night to seek food.

In greenhouses the toad may be made of particular value as a destroyer of snails, sow bugs, myriapods, cut worms and weevils. According to Dr. Ritzema Bos, "in the research garden attached to the Rouen entomological laboratory the snails were entirely exterminated in 1891 as a result of introducing one hundred toads and ninety frogs." In a greenhouse at Malden, Massachusetts, a number of valuable orchids were nearly ruined through the attacks of myriapods and sow bugs. The gardener introduced a number of toads and in a few weeks the pests had nearly disappeared and all damage from that source ceased. A common pest in rose-houses and one that is increasing in spread and damage, is Fuller's rose beetle (*Aramigus fulleri*). While this species has never been identified in the stomachs examined, yet from the common occurrence of other weevils in the stomachs there can be no doubt but that toads confined in rose-houses would render material aid in destroying this insect. It would be necessary to jar the beetles from the bushes at intervals when the toads would doubtless devour the greater part of the weevils falling to the ground.

NATURAL ENEMIES.

The crow and various species of hawks and owls are the chief natural enemies of the toad. According to Prof. W. B. Barrows,* "it is certain that crows consume large numbers of toads and frogs." Examinations made by him of the stomachs of a large number of crows show that the toad is a common element in the food of this bird. From Dr. A. K. Fisher's Report on the Hawks and Owls of the United States, I take the following list of birds known to feed on the toad: red-tailed hawk, broad-winged hawk, red-shouldered hawk, screech owl. To the above list my friend, Mr. F. H. Mosher, adds the marsh hawk, which, he states, is one of the worst enemies of toads, destroying large numbers of them during the spawning season. Mr. Mosher also informs me that he has found a toad in the nest of a Cooper's hawk. It is probable that all the hawks and owls occurring in this region feed upon the toad to a considerable extent. While young toads are migrating from the ponds, many of them are destroyed by hens, ducks and guinea fowls. Several snakes have been reported to me as destroying toads, but unfortunately none were submitted for identification. In Germany, a dipterous parasite, *Lucilia sylvarum* Meig., has been reared from the European toad and larvae, apparently those of *Lucilia*, were found by Meinert in the eye of a toad.

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*The Common Crow, Bull. 6, U. S. Dep. Agr. Div. of Ornith. and Mamm. 1895, p. 51.

As a common enemy of the toad the ubiquitous small boy plays a prominent part. At Malden, Massachusetts, the writer once found seventeen toads dead and more or less mutilated, lying on the shores of a small pool. This was the result of a couple of hours' *amusement* on the part of two juveniles. This is not an extreme case.* Such cruel and senseless persecution is only of too common occurrence. The loud cry of the toad at spawning time readily betrays its presence, and small boys, and sometimes those of a larger growth gravitate toward the pools as naturally as do the toads themselves. There have been excellent laws enacted to protect our insectivorous birds. Why should there not be as stringent legislation against the destruction of toads? If merit of service rendered to man be the standard by which legislation is determined, the toad presents a record which will compare favorably with that of any insectivorous bird. Public sentiment in a matter like this, however, exerts a stronger influence than legislation, and when the services of this animal are appreciated and the toad receives in our public schools recognition similar to that given to the birds, then we may expect to see a lessening of the wanton destruction of this humble servant of man.

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*Since the above was written, Dr. C. F. Hodge has published in the *Worcester Evening Gazette*, Mar. 31, 1897, an account of finding in a single day 200 dead and wounded toads on the shores of a small pond on the grounds of Clark University.

LIST OF THE MORE IMPORTANT WORKS CONSULTED IN THE PREPARATION OF THIS PAPER.

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EXPLANATION OF PLATE II.

Figure 1. Lower jaw of toad showing attachment of tongue.
" 2. Side view of head showing tongue in action.
" 3. Alimentary canal stripped of appendages.
" 4. Cardiac orifice of stomach enlarged.
" 5. Empty stomach.

The cuts of insects illustrating this bulletin should be credited to the following sources: Figs. 1, 3, 7, 9, 10, 12, 13, 14, Harris Insects Injurious to Vegetation. Figs. 2, 4, 8, 11, 15, 16, 17, 18, 20, 21, 22, 23, 24, Prof. C. V. Riley. Fig. 19, Prof. S. H. Scudder. Fig. 25, Dept. Agr. Rept. For the use of fig. 2, I am indebted to Prof. J. B. Smith. The cuts from Harris insects were obtained through the kindness of Hon. Wm. R. Sessions, Sec'y State Board of Agriculture, to whom I am also under obligations for the use of fig. 6.

Duplicate

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 47.

ON FIELD EXPERIMENTS WITH TOBACCO IN MASSACHUSETTS.

I. General Discussion of Experiments.
II. Experiments at Hatfield, Mass.
III. Experiments at Agawam, Mass.
IV. Experiments at Westfield, Mass.
V. Summary of Three Years Observations at Hatfield, Agawam and Westfield, 1893—1896.

APRIL, 1897.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1897.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
Leonard Metcalf, B. S.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Fred W. Mossman, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Stephen W. Fletcher, B. Sc.,	*Assistant Horticulturist.*
Benjamin K. Jones, B. Sc.,	*Assistant in Foods and Feeding.*
James L. Bartlett,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

REPORT

On Field Experiments With Tobacco in Massachusetts, 1893—1896.

BY

CHARLES A. GOESSMANN.

I. GENERAL INTRODUCTION.

The experiments described in the following pages were carried on with the coöperation of the Valley Tobacco Experiment Association of Massachusetts. This organization of prominent cultivators of tobacco in the Connecticut River Valley was formed at a public meeting of parties interested in tobacco culture. The meeting was called February 4, 1893, at Northampton, at the suggestion of the writer by W. A. Porter of Agawam, a member of the Board of Control of the Massachusetts Experiment Station.

The officers chosen on that occasion were President, L. A. Crafts of Whately; Vice-President, C. L. Fowler of Westfield; Secretary and Treasurer, G. D. Fisk of Agawam; Board of Directors, W. A. Porter of Agawam and C. L. Warner of Hatfield.

After a general discussion of the object of the meeting the following plan of operation was decided upon:

1. To select suitable lands in different parts of the valley to secure as far as practicable diversity of soil and local climatical conditions. Hatfield, Westfield and Agawam were chosen for the location of the experiments. The selection of the particular field in each place was left to a special committee of the Association. In all cases a deep sandy loam was selected for the trial.

2. To use in each case the same kind and the same amount of fertilizing ingredients, and to continue the observation for three

successive years before publishing the results obtained, in connection with suitable conclusions.

3. To place the entire practical management of soil and of crop, before and after harvesting, in the hands of experienced tobacco growers, the owners of the fields engaged in the trial. A committee of officers of the Association was to visit at stated times the different localities, to report on the condition and the character of the crop raised.

4. To assign to the writer as acting Director of the Massachusetts Agricultural Experiment Station the business of securing and compounding the fertilizers to be used upon the different experiment plats; to measure the plats and to make subsequently a chemical analysis of the crops raised.

The observations in Hatfield by C. L. Warner & Bro., and in Agawam by Geo. D. Fisk began during the spring of 1893, while those in Westfield by C. F. Fowler were deferred until the spring of 1894. They were each continued for three years in succession. Each experiment plat occupied an area of one-twelfth of one acre with from three to four feet of unoccupied space between adjoining plats. The variety of tobacco selected for the trial was Havana Seed. For the purpose of securing uniformity of fertilizer during the years of the experiment, it was decided to purchase at once as far as advisable enough of each kind to supply the needed materials for three years.

Statement of Fertilizers used upon different Plats.

The fertilizer mixture used during the entire time of observation contained in all cases, per acre,

Potassium oxide, (available)	300 pounds.
Nitrogen, (available)	100 pounds.
Phosphoric acid, (available)	60 pounds.

One-fourth of the nitrogen was in all cases used in the form of nitrates of soda or potash, to secure a uniform condition of availability of nitrogen during the early stage of growth.

Chemical composition of different fertilizing ingredients used in compounding the special fertilizers for different plats.—Ingredients containing chlorine were carefully excluded from the mixtures of fertilizers in all cases.

Name of material.	Nitrogen.	Phosphoric acid.	Potassium Oxide	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.
Nitrate of Soda,	15.59	—	—	35.00	—	—
Nitrate of Potash,	12.79	—	45.05	—	—	—
Cotton Seed Meal,	6.50	3.17	2.25	—	*	*
Linseed Meal,	5.91	1.95	1.08	—	*	*
Castor Pomace,	5.60	2.26	3.40	—	*	*
Dissolved Bone-black,	—	13.38	—	—	*	—
Oderless Phosphate, i. e. Phosphatic Slag meal,	—	18.42	—	—	48.27	—
High Grade Sulphate of Potash,	—	—	50.20	—	—	—
Potash-Magnesia Sulphate,	—	—	24.32	—	—	12.58
Cotton Seed Hull Ashes,	—	7.93	23.96	—	9.30	10.47
Carbonate of Potash-Magnesia,	—	—	18.48	—	—	19.52
Barnyard Manure,	0.52	0.39	0.56	—	*	*

*Not determined.

Preparation of Fertilizers.

The special fertilizer mixtures used in the case of the different plats were prepared from the above stated materials at the Mass. Experiment Station at Amherst, Mass.

They were selected in each case, as far as desired with reference to *different forms* of potash, of nitrogen and of phosphoric acid to study their influence on quantity *and in particular on the quality of the tobacco crop raised* under otherwise fairly corresponding conditions.

PLAT 1.

Name of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre.		
		Phosphoric acid.	Potassium Oxide.	Nitrogen.
Nitrate of Potash,	195.	—	88.	25.
Cotton Seed Meal,	1154.	37.	26.	75.
Dissolved Bone-black,	175.	23.	—	—
Potash-Magnesia Sulphate,	765.	—	186.	—
Total,		60.	300.	100.

Plat 2.

Name of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre.		
		Phosphoric acid.	Potassium oxide.	Nitrogen.
Nitrate of Potash,	195.	—	88.	25.
Castor Pomace,	1340.	31.	45.	75.
Dissolved Bone-black,	221.	29.	—	—
Potash-Magnesia Sulphate,	685.	—	166.5	—
Total,		60.	299.5	100.

Plat 3.

Name of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre.		
		Phosphoric acid.	Potassium oxide.	Nitrogen.
Nitrate of Soda,	160.3	—	—	25.
Cotton Seed Meal,	1154.	37.	26.	75.
Cotton Seed Hull Ashes,	1142.	90.56	274.	—
Total,		127.56	300.	100.

Plat 4.

Name of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre.		
		Phosphoric acid.	Potassium oxide.	Nitrogen.
Nitrate of Soda,	160.3	—	—	25.
Castor Pomace,	1340.	31.	45.50	75.
Cotton Seed Hull Ashes,	1060.	84.1	253.97	—
Total,		115.1	299.47	100.

PLAT 5.

No manure at any time during the experiment.

PLAT 6.

Name of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre.		
		Phosphoric acid.	Potassium oxide.	Nitrogen.
Nitrate of Soda,	160.3	—	—	25.
Cotton Seed Meal,	1154.	37.	26.	75.
Dissolved Bone-black,	175.	23.	—	—
High Grade Sulphate of Potash,	545.8	—	274.	—
Total,		60.	300.	100.

PLAT 7.

ame of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre.		
		Phosphoric acid.	Potassium oxide.	Nitrogen.
Nitrate of Soda,	160.3	—	—	25.
Castor Pomace,	1340.	31.	45.50	75.
Dissolved Bone-black,	221.	29.	—	—
High Grade Sulphate of Potash,	506.	—	254.50	—
Total,		60.	300.	100.

PLAT 8.

Name of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre. Phosphoric acid.	Potassium oxide.	Nitrogen.
Nitrate of Soda,	160.3	—	—	25.
Linseed Meal,	1271.	24.78	14.	75.
Dissolved Bone-black,	263.	35.22	—	—
High Grade Sulphate of Potash,	569.7	—	286.	—
Total,		60.	300.	100.

PLAT 9.

Name of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre. Phosphoric acid.	Potassium oxide.	Nitrogen.
Nitrate of Potash,	195.	—	88.	25.
Cotton Seed Meal,	1154.	37.	26.	75.
Cotton Seed Hull Ashes,	776.	62.	186.	—
Total,		99.	300.	100.

PLAT 10.

Name of fertilizing material used.	Pounds per acre.	Pounds of fertilizing elements per acre. Phosphoric acid.	Potassium oxide.	Nitrogen.
Nitrate of Potash,	195.	—	88.	25.
Castor Pomace,	1340.	31.	45.50	75.
Phosphatic Slag Meal,	157.	29.	—	—
Carbonate of Potash-Magnesia,	900.9	—	166.50	—
Total,		60.	300.	100.

PLATS 11 and 12.

Name of fertilizing material used. Average analysis of seventy-five samples tested at the station laboratory at Amherst, Mass.	Pounds per acre.	Pounds of fertilizing elements per acre.		
		Phosphoric acid.	Potassium oxide.	Nitrogen.
Barnyard Manure,	20,000	78.0	112.0	104.0

Barnyard manure was added in several localities to the list of fertilizers on trial during the second year. It was slightly ploughed under during the preceding autumn to secure a suitable disintegration. Cost of fertilizer per acre when bought 1893:

Plat 1,	$36.70	Plat 7,	$29.30
Plat 2,	33.70	Plat 8,	37.20
Plat 3,	42.40	Plat 9,	38.30
Plat 4,	38.70	Plat 10,	35.90
Plat 5,	nothing.	Plat 11,	at local cost.
Plat 6,	32.30		

Average cost, (per acre), $36.10

Cost of materials in 1893, per ton of 2000 pounds, including freight at Amherst, Massachusetts:

Castor Pomace,	$23.40
Cotton Seed Meal,	31.00
Linseed Meal,	34.80
Nitrate of Potash,	87.40
Nitrate of Soda,	49.40
Cotton Seed Hull Ashes,	50.40
High Grade Sulphate of Potash,	52.40
Sulphate of Potash-Magnesia,	40.40
Carbonate of Potash-Magnesia,	39.10
Dissolved Bone-black,	24.20
Phosphatic Slag Meal,	19.00
Barnyard Manure,	at local cost.

A comparison of the cost of most fertilizing ingredients above stated with that charged at the present time averages approximately 25% less—in favor of the present year.

The statements of actual yield of tobacco per plat is in all cases supplemented by a statement of yield of tobacco for one thousand plants actually harvested to exclude such varying incidental influences as cutworm, etc., from affecting the conclusions drawn from the results.

II. EXPERIMENTS ON THE FARM OF C. S. WARNER AT HATFIELD, MASS.
1893—1894—1895.

1893. First year. The field selected for the observation covered an area of three hundred and twenty-four feet in length and one hundred and thirty feet in width. It was located along a highway in the middle of a district almost exclusively devoted to the raising of tobacco. The field was divided into two plats of equal length and width, leaving four feet of unoccupied space between them. Each of these plats was again divided into five parallel running plats of equal size and shape, with three feet of space between adjoining plats, making ten plats in all; each of these plats measured three thousand six hundred and thirty-four square feet, or approximately one-twelfth of one acre. At the close of the month of April, after a careful mechanical preparation of the soil, each plat received one of the above stated mixed fertilizers, strewn broadcast, and well ploughed under before planting. The setting of tobacco plants took place on the same day, May 7th, seven rows of plants, three feet apart, in each plat, with plants two feet from each other in the row. The dryness of the season and ravages of cutworms necessitated here and there resetting of the plants. The field when visited by the writer July 8th, '93, was found in good condition, and compared favorably with surrounding tobacco fields.

The following table gives the number of plants harvested in 1893:

Plat 1,	546 plants.	Plat 6,	526 plants.
Plat 2,	554 plants.	Plat 7,	546 plants.
Plat 3,	570 plants.	Plat 8,	567 plants.
Plat 4,	577 plants.	Plat 9,	568 plants.
Plat 5,	591 plants.	Plat 10,	567 plants.

The average number of plants, per plat, set was 585.6, the average number of plants harvested per plat was 561.2; the average number of plants missing was 4.4%.

The plants were cut and housed August 10th and stripped October 13th. The crop was inspected December 25th by the appointed committee, Messrs. W. A. Porter and Geo. D. Fisk of Agawam, L. A. Crafts of Whately and C. L. Warner of Hatfield.

REPORT OF COMMITTEE ON CROP 1893.

Rank of Plats.

1. Texture, color, vein. Plats 9, 10, 7, 8, 6, 4, 2, 1, 3, and 5.
2. Total weight per plat. Plats 1, 4, 9, 10, 2, 7, 8, 3, 5, and 6.
3. Weight and percentage of wrapper, Plats 10, 9, 4, 2, 6, 8, 7, 3, 1 and 5.
4. Burning quality; only one test was made by committee and results were not considered reliable. The test was referred to the laboratory of the Experiment Station. See succeeding statements.

Plats.	Tobacco pounds.	Plats.	Wrapper pounds.	Wrapper per cent.
1	145	10	96	71.63
4	139	9	87	60.40
9	134	4	76	54.80
10	134	2	53	40.46
2	131	6	45	37.10
7	129	8	43	33.33
8	129	7	42	32.56
3	129	3	42	32.56
5	128	1	41	28.28
6	121	5	27	21.10

After sweating, the tobacco grown on plats 9 and 10 was considered best; that grown on Plats 2, 4, 6, and 8 were marked good; that on Plats 1, 3, and 7 medium while that grown on Plat 5 was dark in color and below medium.

LABORATORY TEST ON FIRE HOLDING CAPACITY.

This was determined in the air dried leaves by bringing the leaf, held in a horizontal position, in contact with a lighted slow-match, and noting the number of seconds elapsing between the instant of contact and the dying out of the last trace of fire in the leaf. Five leaves were selected from each lot and six tests were made on each leaf, three on each side of the midrib, one near the tip, one near the middle and the third near the base of the leaf. Thus it is apparent that the figures stated below represent the average of thirty determinations.

HATFIELD.

According to plats.		According to plats.	
Plat.	Seconds.	Plat.	Seconds.
1	12	6	8
2	4	7	15
3	11	8	13
4	8	9	5
5	6	10	15

QUALITY OF ASH.

The relative burning quality of the wrappers of the different plats was determined by wrapping small cigars (Blackstone Juniors) with sections of the leaves, and smoking them by means of an aspirator. Three determinations were made on each plat, all of the cigars being preserved until the close of the operation, and the comparison of ash being made by a careful examination and arrangement according to quality.

The results are given below:

Rank of Plat: 9, 10, 4, 5, 3, 1, 6, 2, 8, 7.

Second year at Hatfield. 1894. The field, the general arrangement of the plats and the different fertilizers used upon the plats were the same as in the preceding year. The preparation of the soil was also the same.

Two new plats of corresponding size and shape running along the west side of the entire field were added to compare the effect of an average barn-yard manure with that of chemicals and chemical fertilizers on the quality and quantity of the tobacco raised. Eight rows of plants were set in each plat two feet and eight inches apart, instead of seven rows three feet apart as in 1893; the plants were two feet apart, as before, in the row. The setting of all of the plats took place May the 18th. The plants were topped July the 18th with the exception of those upon the unfertilized plat (5) which was deferred until July 22nd. The crop was cut and housed August 10th.

Number of plants in plats when harvested.

Plat 1,	647	Plat 7,	641
Plat 2.	647	Plat 8,	638
Plat 3,	646	Plat 9,	600
Plat 4,	588	Plat 10,	592
Plat 5,	603	Plat 11,	579
Plat 6,	639	Plat 12,	604

REPORT OF COMMITTEE ON CROP (1894).

Rank of Plats.

1. Texture, color, vein, Plats 3, 8, 10, 7, 4, 12, 11, 9, 6, 5, 2, and 1.
2. Total weight of tobacco, Plats 11, 8, 3, 12, 2, 10, 7, 9, 1, 5, 6, 4.
3. Percentage of wrapper, Plats 8, 9, 3, 10, 11, 6, 5, 12, 7, 2, 4, 1.

ACTUAL YIELD PER PLAT.

Plats.	Tobacco pounds.	Plats.	Wrapper pounds.	Wrappers per cent.
11	140	8	87	64.40
8	135	3	79	58.51
3	135	9	76	59.38
12	135	11	74	52.86
2	134	10	70	53.02
10	132	12	64	47.40
7	132	5	63	50.80
9	128	6	63	51.64
1	126	7	61	46.21
5	124	2	59	44.03
6	122	1	49	38.89
4	119	4	48	40.35

QUALITY OF ASH AND FIRE HOLDING CAPACITY.

Quality of Ash.	Fire holding capacity.	
	According to plats.	
Plats.	Plat.	Seconds.
4	1	6
10	2	6
3	3	45
11	4	40
8	5	17
12	6	8
9	7	11
1	8	19
2	9	10
5	10	36
7	11	59
6	12	9

Third year at Hatfield, (1895.) The same field, the same arrangement of plats and the same kinds of fertilizers were used as in the preceding year. The tobacco was set May 28th, topped July 3rd, cut and housed July 29th. The tobacco was stripped October 15th and 16th.

NUMBER OF PLANTS HARVESTED PER PLAT.

Plats.	Number of plants.	Plats.	Number of plants.
1	630	7	603
2	630	8	604
3	645	9	625
4	686	10	620
5	610	11	640
6	612	12	625

Report of Committee on Crop, (1895.)

Rank of Plats.

Texture, color, vein. Plats 9, 11, 4, 3, 10, 8, 7, 6, 2, 1, 5.

Total weight of tobacco. Plats 11, 3, 2, 6, 8, 9, 10, 1, 4, 7, 5.

Percentage of wrapper. Plats 9, 3, 4, 10, 6, 11, 7, 8, 5, 2, 1.

ACTUAL YIELD PER PLAT.

Plats.	Tobacco pounds.	Plats.	Wrapper pounds.	Wrappers per cent.
11	142	9	84	63.06
2	135	3	83	61.50
3	135	4	78	59.60
6	134	10	77	57.89
8	134	11	76	53 52
9	133	6	76	56.71
10	133	8	68	50.74
1	133	7	66	52.38
4	131	2	54	40.00
7	126	5	53	42.74
5	124	1	49	36.84

QUALITY OF ASH AND FIRE HOLDING CAPACITY. HATFIELD, 1895.

Laboratory Tests.

Quality of Ash.	Fire holding capacity. According to plats.	
Plats.	Plats.	Seconds.
4	1	37
3	2	41
9	3	393
10	4	773
7	5	31
6	6	22
12	7	25
5	8	20
8	9	1469
11	10	82
2	11	123
1	12	14

The test for the quality of the ash was made in the above case with small cigars made from the product of each plat. The results with two or three exceptions—1, 2, 11,—were very satisfactory, the ash being of a uniform light shade and compact.

ANALYSIS OF TOBACCO. HATFIELD. THIRD YEAR, 1895.

(Whole Leaf.)

No. of Plats.	1	2	3	4	5	6	7	8	9	10	11&12
Moisture,	12.71	12.48	11.16	12.08	18.50	12.48	12.05	11.65	12.00	12.95	11.61
Nitrogen,	2.63	2.35	2.27	2.54	2.15	2.14	2.62	2.81	1.54	2.68	2.50
Phosphoric acid	.48	.46	.43	.44	.31	.39	.53	.50	.36	.39	.46
Sulphuric acid,	2.29	2.23	1.53	1.75	1.53	2.04	2.28	1.72	1.13	1.51	1.70
Chlorine,	.07	.094	.02	.02	.02	.099	.17	.06	.08	.005	.198
Potass'm oxide,	6.78	6.93	6.89	6.95	5.93	7.46	6.81	7.17	7.11	6.59	6.58
Sodium oxide,	1.76	2.07	1.99	2.74	1.84	1.51	1.71	1.94	1.91	1.87	1.67
Calcium oxide,	4.08	4.30	4.80	4.72	4.65	4.73	3.48	4.35	4.82	3.50	4.43
Magnes'm oxide	.79	1.47	1.71	1.51	1.35	.74	.45	1.85	1.53	1.32	.97
Iron & Al. oxide	.55	.60	.75	.45	.35	.60	.50	.45	.82	.50	.60
Total ash as sulphates,	27.02	30.00	32.28	33.75	27.75	32.55	28.32	28.70	36.72	28.70	30.45
Sulphuric acid in ash less sulphuric acid in plants,	10.51	12.02	11.90	14.66	11.66	11.55	11.04	12.39	15.35	12.53	12.65
Silicious material insoluble in diluted hydrochlor. acid,	3.43	4.65	5.61	2.58	2.38	3.76	3.69	2.38	5.32	2.66	3.78

H. D. HASKINS, Analyst.

The determination of total ash was made in form of sulphates instead of carbonates to secure more reliable figures for comparing results.

SUMMARY OF TOBACCO EXPERIMENT. HATFIELD.

Number of plants harvested and weight of tobacco.

	Number of plants harvested per plat.			Weight of tobacco per plat. (lbs.)			Weight of tobacco per 1000 plants harv'd. lbs.		
	1893	1894	1895	1893	1894	1895	1893	1894	1895
Plat 1,	546	647	630	145	126	133	266	195	211
Plat 2,	554	647	630	131	134	135	236	207	214
Plat 3,	570	646	645	129	135	135	226	209	209
Plat 4,	577	588	686	139	119	131	241	202	191
Plat 5,	591	603	610	128	124	124	217	206	203
Plat 6,	526	639	612	121	122	134	230	191	218
Plat 7,	546	641	603	129	132	126	236	206	209
Plat 8,	567	638	604	129	135	134	228	212	222
Plat 9,	568	600	625	134	128	133	236	213	213
Plat 10,	567	592	620	134	132	133	236	223	211
Plat 11,	—	579	640	—	140	142	—	242	222
Plat 12,	—	604	625	—	135	—	—	223	—

SUMMARY OF YIELD OF TOBACCO AND OF PER CENT OF WRAPPER PER ONE THOUSAND PLANTS. HATFIELD.

Per 1000 plants.	Tobacco total yield. (lbs.)			Amount of wrapper. (lbs.)			Per cent of wrapper.		
	1893	1894	1895	1893	1894	1895	1893	1894	1895
Plat 1,	266	195	211	75.1	75.9	77.66	28.23	38.88	36.80
Plat 2,	236	207	214	95.5	91.1	85.60	40 50	44.02	40.00
Plat 3,	226	209	209	73.6	122.3	128.40	32.56	58.50	61.43
Plat 4,	241	202	191	132.	81.3	113.70	54.80	40.24	59.50
Plat 5,	217	206	203	45.8	104.7	87.00	21.20	50.82	42.85
Plat 6,	230	191	218	85.6	98.6	123.60	37.20	51.64	56.70
Plat 7,	236	206	209	76.8	95.2	109.10	32.54	46.21	52.20
Plat 8,	228	212	222	76.0	136.6	112.10	33.33	64.43	50.50
Plat 9,	236	213	213	142.6	126.4	134.50	60.42	59.34	63.14
Plat 10,	236	223	211	169.0	118.1	122.00	71.64	53.02	57.82
Plat 11,	—	242	222	—	127.1	119.00	—	52.50	53.60
Plat 12,	—	223	232	—	105.7	—	--	47.40	—

III. EXPERIMENTS AT AGAWAM, ON THE FARM OF GEO. D. FISK.

1893—1894—1895.

The field used for the experiment covered an area of 41,419 square feet, being four hundred and twenty-seven feet long and ninety-seven feet wide. The land had served in preceding years for the production of general farm crops and had never been used for the cultivation of tobacco. It was divided by means of an unoccupied space, four feet in width, running through the center of the field, into two parts of equal length and width. Each of these parts was subsequently sub-divided into five plats, making ten plats in all.

The ten plats were of equal size and shape with an unoccupied space of three feet in width separating adjoining plats. Each plat measured three thousand six hundred and twenty-nine and one-half square feet, equal, approximately to one-twelfth of one acre. They received the same kind and the same amount of fertilizer as the plats at Hatfield. The fertilizers were applied broadcast and were well harrowed in at the close of the month of April.

First Year (1893.) After a careful mechanical preparation of the soil, the plants were set out June 13th and 14th. Each plat contained five rows three feet apart with plants eighteen inches from each other in the row. Dry weather and the work of the cutworm necessitated a resetting of plants in many instances. At the time of the first hoeing, June 28th, the crop looked well as far as color was concerned, but suffered much subsequently from dry weather in July and August and also from two severe wind storms during the latter month.

The general appearance of the field at the close of the season however compared well with other tobacco fields in the vicinity. The tobacco was harvested September 11th and 12th. It cured well with a light color.

NUMBER OF PLANTS HARVESTED.

Plat 1,	701	Plat 6,	668
Plat 2,	695	Plat 7,	682
Plat 3,	701	Plat 8,	695
Plat 4,	701	Plat 9,	705
Plat 5,	722	Plant 10,	690

REPORT OF COMMITTEE ON CROP 1893.

Rank of Plats.

Texture, color, vein, Plats 4, 2, 8, 1, 3, 9, 7, 6, 10, 5.

Weight of tobacco, Plats 7, 4, 2, 10, 3, 8, 1, 6, 9, 5.

Percentage of wrappers, Plats 1, 2, 5, 3, 4, 7, 10, 8, 9, 6.

ACTUAL YIELD OF PLATS.

Plats.	Weight of tobacco. (lbs.)	Percentage of wrappers. (lbs.)
7	153.5	9.12
4	151.5	11.88
2	142.5	25.96
10	139.	9.
3	134.	18.66
8	134.	8.58
1	127.	37.79
6	117.5	6.80
9	115.5	9.91
5	114.	24.56

QUALITY OF ASH AND FIRE HOLDING CAPACITY. FIRST YEAR.

Quality of Ash.	Fire holding capacity.	
	According to plats.	
Plats.	Plat.	Seconds.
2	1	8
6	2	53
9	3	10
10	4	72
5	5	27
4	6	44
3	7	12
8	8	15
1	9	18
7	10	52

The results of the experiment showed in many ways the adverse influence of an unfavorable season.

Second year, (1894.) The field, the arrangement of the plats and the application of the fertilizers used, were the same as in the preceding year. One plat was added to the list to compare the effect of barnyard manure, under otherwise fairly corresponding conditions with that of the various mixtures of chemicals and commercial fertilizing materials used upon the other plats. The new plat (Plat 11) received 1640 pounds of barnyard manure per plat or ten tons per acre.

The tobacco plants were set out June 5th upon plats 1, 10, 2, 9, 3, 8, and part of 4 and 7; the remainder were set June 7th and 8th.

The growth of plants was on the whole very satisfactory and but few plants were missing and the crop when harvested, September 7th and 8th, in the opinion of Mr. Fisk was much better than the crop raised during the preceding year and compared very favorably with the crops of tobacco-fields in this vicinity.

NUMBER OF PLANTS HARVESTED.

Plat 1,	697	Plat 7,	686
Plat 2,	695	Plat 8,	707
Plat 3,	708	Plat 9,	722
Plat 4,	706	Plat 10,	699
Plat 5,	706	Plat 11,	692
Plat 6,	710.		

Report of Committee on Crop of 1894.

Rank of Plats.

Texture, color, vein, Plats 9, 8, 7, 10, 6, 4, 3, 2, 5, 1, 11.
Weight of tobacco, Plats 9, 7, 4, 3, 8, 2, 10, 1, 5, 6, 11.
Percentage of wrappers, Plats 9, 8, 7, 10, 6, 4, 3, 1, 2, 5, 11.

ACTUAL YIELD OF PLATS.

Plats.	Weight of tobacco.	Weight of wrappers.	Percentage of wrappers.
9	156.5	69.5	44.56
7	151.	57.	37.75
4	148.	32.	21.62
3	148.	28.	19.05
8	145.	57.	39.31
2	134.	19.	14.18
10	123.	46.	37.40
1	120.	21.	17.50
5	114.	10.	8.77
6	112.	30.	26.83
11	78.5	3.5	4.46

QUALITY OF ASH AND FIRE HOLDING CAPACITY (SECOND YEAR, 1894.)

Quality of ash.	Fire holding capacity.	
	According to plats.	
Plats.	Plats.	Seconds.
3	1	4.
9	2	5.
4	3	10.5
10	4	7.
5	5	2.5
8	6	5.
7	7	4.3
6	8	4.3
2	9	3.8
11	10	3.4
1	11	4.

Third Year (1895.) The field, the general arrangement and management of the plats and the kind and amount of fertilizers were the same as in preceding years. The plants were set out during the last week in May. A considerable number of the plants had to be reset on account of the work of the cutworm and the imperfect work of the machine used in setting.

A hailstorm passed over the field July 13th, it did but little damage however on account of the small size of the plants. The crop was harvested rather late (September 10 and 12) on account of its maturing so slowly.

The number of plants per row averaged one hundred and thirty-nine, there being five rows in each plat.

NUMBER OF PLANTS HARVESTED.

There was on an average 695 plants in each plat; detailed record was lost.

Report of Committee (1895.)

Rank of Plats.

Texture, color, vein, Plats 9, 4, 10, 3, 8, 11, 7, 2, 1, 6, 5.

Weight of tobacco, Plats 4, 8, 10, 1, 2, 3, 9, 7, 11, 6, 5.

Percentage of wrappers, Plats 11, 10, 9, 3, 4, 8.

ACTUAL YIELD OF PLATS. (POUNDS.)

Plats.	Weight of tobacco.	Weight of wrappers.	Percentage of wrappers.
4	154.5	2.5	1.61
8	145.5	.5	.34
10	136.5	8.0	5.86
1	135.5	—	—
2	130.	—	—
3	130.	4.0	3.07
9	129.	5.5	4.26
7	111.	—	—
11	104.5	11.	10.52
6	102.5	—	—
5	68.	—	—

QUALITY OF ASH AND FIRE HOLDING CAPACITY. AGAWAM. 1895.

Quality of ash.	Fire holding capacity.	
Plats.	Plats.	Seconds.
10	1	10
4	2	76
3	3	12
9	4	62
8	5	8
11	6	12
6	7	21
2	8	55
1	9	39
5	10	32
7	11	36

AGAWAM. ANALYSIS OF TOBACCO. 1895.

Whole Leaf.

Number of plat.	1	2	3	4	5	6	7	8	9	10	11
Moisture,	7.51	7.72	8.61	8.33	7.72	9.57	7.55	7.90	8.22	8.77	7.42
Nitrogen,	1.75	2.08	2.21	2.50	2.24	2.22	1.99	2.22	2.27	2.62	2.16
Phosphoric acid	.38	.40	.33	.41	.55	.33	.27	.26	.34	.34	.35
Sulphuric acid,	1.85	2.44	1.30	1.46	1.73	2.28	2.08	1.89	1.24	1.01	1.87
Chlorine,	.84	.084	.101	.122	.406	.291	.06	.15	.099	.22	.54
Potass'm oxide,	5.62	5.36	5.80	6.13	2.00	6.48	6.30	6.80	5.54	5.28	5.43
Sodium oxide,	2.60	2.37	2.80	3.40	3.79	3.93	2.70	4.13	1.82	2.28	2.82
Calcium oxide,	4.92	3.52	3.78	3.68	3.43	4.03	4.68	4.68	3.78	3.17	4.02
Magnes'm oxide	1.36	1.74	2.07	1.70	1.49	1.08	1.18	1.30	1.94	2.37	1.33
Iron & Al. oxide	.93	1.00	.94	.59	.26	.39	.52	.55	.45	.45	.55
Total Ash as Sulphates,	33.29	36.04	33.38	31.06	25.43	29.40	30.92	29.70	28.90	27.37	26.37
Sulphuric acid in ash less sulphuric acid in plant,	12.97	11.64	14.41	13.25	10.09	12.03	12.10	10.56	12.53	12.73	10.70
Silicious material insoluble in diluted hydrochlor. acid	6.91	7.73	4.90	2.50	3.01	2.93	3.91	3.00	4.00	2.80	2.38

Total ash has been determined in form of sulphates instead of carbonates for reason stated.

H. D. Haskins and R. H. Smith, Analysts.

SUMMARY OF TOBACCO EXPERIMENTS. AGAWAM.

Number of plants harvested and weight of tobacco per plat.

	Number of plants per plat.			Weight of tobacco per plat. (lbs.)			Weight of tobacco per 1000 plants. (lbs.)		
	1893	1894	1895	1893	1894	1895	1893	1894	1895
Plat 1,	701	697	139 plants in each row; five rows in each plat; average per plat 695 plants.	127	120	135.5	187.2	172.2	195
Plat 2,	695	695		142.5	134	130	203.6	193.0	187
Plat 3,	701	708		134	148	130	191.1	209	187
Plat 4,	701	706		151.5	148	154.5	214.7	208.6	222.3
Plat 5,	722	706		114	114	68	158	161.5	97.8
Plat 6,	668	710		117.5	112	102.5	176	157.8	148
Plat 7,	682	686		153.5	151	111	225.1	220.1	160
Plat 8,	695	707		134	145	145 5	192.8	205.1	209.3
Plat 9,	705	722		115.5	156.5	129	163.8	216.6	185.6
Plat 10,	690	699		139	123	136.5	201.5	176	196.4
Plat 11,	—	692		.	78.5	104.5	—	113.4	150.4

SUMMARY OF YIELD OF TOBACCO PER 1000 PLANTS AND OF PER CENT OF WRAPPER AGAWAM.

	Tobacco total yield (lbs.)			Wrapper total yield (lbs.)			Per cent of wrapper.		
	1893	1894	1895	1893	1894	1895	1893	1894	1895
Plat 1,	181.2	172.2	195.	—	30.1	—	—	17.5	—
Plat 2,	203.6	193.0	187.	Crop was sold in bulk.	27.4	—	—	14.2	—
Plat 3,	191.1	209.	187.		39.6	5.8	Not ascertained.	19.0	3 1
Plat 4,	214.7	208.6	222.3		45.1	3.6		21.62	1.6
Plat 5,	158.	161 5	97.8		14.2	—		8.8	—
Plat 6,	176.	157.8	148		42.3	—		26.8	—
Plat 7,	225.1	220.1	160.		83.1	—		37 8	—
Plat 8,	192.8	205.1	209 3		80.6	.72		39.3	.35
Plat 9,	163.8	216.6	185.6		96.2	8.0		44.4	4.3
Plat 10,	201.5	176.	196.4		66 0	11.5		37.5	5.8
Plat 11,		113.4	140.5		5.1	15.8		4.5	10.5

IV. EXPERIMENTS ON THE FARM OF C. F. FOWLER, WESTFIELD, MASS., 1894—1895 –1896.

The field engaged in the observations covers an area, four hundred and ten feet long and one hundred and one feet wide, which is divided in the center by a strip of unoccupied space five feet wide into two parts of equal size and shape, 205 by 101 feet. Each of these was subdivided into five plats ; these parallel plats were separated from each other by an unoccupied space three feet in width. The ten plats thus obtained were of a uniform size and shape, each covering an area of three thousand six hundred and thirteen feet, or approximately one-twelfth of an acre. The soil is a light, sandy loam, locally known by the name of light, sandy plain. The field is situated in the midst of a locality devoted largely to tobacco culture, but the field selected for our observations had never received any fertilizing material, with the exception of fifty bushels of leached ashes some ten years previous to 1894; for ten years past it had been cropped with corn and rye, but never with tobacco.

First Year (1894). The mechanical preparation of the soil and the kind of fertilizers used upon each plat, as well as the variety of tobacco selected and the general management of the crop during the season and after harvesting the tobacco, was materially the same as in the case of the experiments carried on at Hatfield and Agawam. The plats were laid out April 30, 1894; the fertilizers were harrowed in by an Acme harrow May 8th, and the tobacco plants set out by a machine June 6th. Each plat contained six rows, three and one-fourth feet apart, with twenty inches space between plants in the row.

The cutworms were somewhat troublesome, particularly on Plats 8, 9, 10, causing a resetting of many plants. Most of the plants were topped July 23d. The crop on all plats was cut and housed August 17th and 18th. All plats suffered somewhat from a serious drought.

NUMBER OF PLANTS HARVESTED PER PLAT, 1894.

Plat 1,	685.	Plat 6,	673.
Plat 2,	672.	Plat 7,	684.
Plat 3,	678.	Plat 8,	695.
Plat 4,	667.	Plat 9,	640.
Plat 5,	635.	Plat 10,	672.

REPORT OF COMMITTEE ON CROP, 1894.

Rank of Plats.

Texture, color, vein, Plats 10, 3, 7, 2, 4, 8, 9, 6, 1, 5.

Total weight of tobacco, Plats 8, 7, 4, 6, 3, 10, 2, 1, 9, 5.

Percentage of wrappers, Plats 2, 4, 3, 8, 7, 1, 9, 10, 6, 5.

ACTUAL YIELD PER PLAT. (POUNDS.)

Plats.	Weight of tobacco.	Weight of wrappers.	Percentage of wrappers.
8	132	68	51.51
7	130	72.5	55.77
4	128	79.5	62.11
6	125	65	52.00
3	123	74	60.16
10	117.5	62.5	53.10
2	107	44.5	41.60
1	106	45.5	42.92
9	101.5	56.5	55.66
5	80	39	48.75

QUALITY OF ASH AND FIRE HOLDING CAPACITY. (FIRST YEAR.)

Quality of ash.	Fire holding capacity.	
	According to plats.	
Plats.	Plat.	Seconds.
10	1	3
4	2	4
1	3	11
2	4	15
8	5	5.5
5	6	12
9	7	18
6	8	6.5
3	9	6.5
7	10	6

Second Year. (1895.) The management of the second year's experiment was essentially the same as in the preceding year, as far as arrangement of plats and kind and amount of fertilizer was concerned. The tobacco plants were set out June 11. The cut worms were troublesome making the tobacco uneven in growth, although the different plats averaged about alike in that respect. The crop was cut and housed August 26th.

NUMBER OF PLANTS HARVESTED PER PLAT.

Plat 1,	(record lost.)	Plat 6,	(record lost.)
Plat 2,	585.	Plat 7,	605.
Plat 3,	600.	Plat 8,	605.
Plat 4,	615.	Plat 9,	565.
Plat 5,	580.	Plat 10,	590.

REPORT OF COMMITTEE ON CROPS, 1895.

Rank of Plats.

Texture, color, vein, Plats, 3, 4, 2, 10, 6, 9, 7, 8, 1, 5.
Total weight of tobacco, Plats, 3, 4, 7, 8, 2, 6, 9, 10, 1, 5.
Percentage of wrappers, Plats, 2, 4, 3, 8, 7, 1, 9, 10, 6, 5.

ACTUAL YIELD PER PLAT. (POUNDS.)

Plats.	Weight of tobacco.	Weight of wrappers.	Percentage of wrappers.
3	147	39	26.53
4	147	45.5	30.95
7	145	37	25.60
8	142.5	37.5	26.31
2	141	48	34.04
6	141	16	11.35
9	138	24	17.39
10	134.5	17.5	13.01
1	129	26	20.15
5	94	6	6.39

QUALITY OF ASH AND FIRE HOLDING CAPACITY (SECOND YEAR).

No statement received.

Third Year (1896). The plats were prepared the same as in preceding years with the exception of plat 5, which had hitherto received no fertilizer whatever; 739 pounds of Canada wood ashes were applied to the plat. The plants were set June 9th, they subsequently suffered somewhat from the cutworms. The tobacco was cut and housed August 25th.

NUMBER OF PLANTS HARVESTED PER PLAT.

Plat 1,	677	Plat 6,	682
Plat 2,	692	Plat 7,	696
Plat 3,	705	Plat 8,	701
Plat 4,	688	Plat 9,	685
Plat 5,	684	Plat 10,	681

Report of Committee on Crop (1896.)

Rank of Plats.

Texture, color, vein, Plats 4, 9, 2, 8, 10, 6, 7, 5, 1, 3.
Total weight of tobacco, Plats, 8, 2, 3, 4, 6, 1, 10, 9, 7, 5.
Percentage of wrapper, Plats, 8, 6, 10, 4, 9, 3, 2, 7, 5, 1.

The entire crop was pronounced by the committee of inspection, to be, with the exception of the samples from plats 5, 1, 3, a first class article, as far as dark as well as light shades were concerned.

ACTUAL YIELD PER PLAT. (POUNDS, 1896.)

Plats.	Weight of tobacco.	Weight of wrappers.	Percentage of wrappers.
1	141.5	83.5	59.01
2	147.5	99.5	67.45
3	145.	98.	67.58
4	143.	101.	70.63
5	100.5	61.5	61.19
6	141.5	111.5	78.79
7	133.	83.5	62.78
8	152.	126.	82.89
9	134.5	95.	70.63
10	135.	100.	74.07

QUALITY OF ASH AND FIRE HOLDING CAPACITY. WESTFIELD, 1896.

Quality of ash.	Fire holding capacity.	
	According to plats.	
Plats.	Plats.	Seconds.
4	1	12.5
9	2	7.0
10	3	8.0
3	4	14.0
5	5	30.2
6	6	12.5
8	7	6.6
7	8	22.4
2	9	20.1
1	10	15.5

ANALYSIS OF TOBACCO. WESTFIELD 1896.

(Whole Leaf.)

	1	2	3	4	5	6	7	8	9	10
Moisture,	10.42	6.28	9.75	14.71	9.85	8.89	10.53	10.60	9 58	10.10
Nitrogen,	2.29	2.70	3.22	2.74	2.22	3.01	2.47	2.68	2.79	3.28
Phosphoric acid,	.52	.49	.51	.46	.53	.49	.50	.43	.47	.50
Sulphuric acid,	1.38	1.76	1.30	.86	1.30	1.69	1.70	1.55	.91	.97
Chlorine,	.256	.036	.074	.203	.118	.202	.124	.153	.059	.292
Potassium oxide,	5.06	4 98	4.92	4.99	5.10	5.47	5.09	4.88	4.37	4.59
Sodium oxide,	2.89	2.96	2.93	2.79	2.24	2.03	2.20	2.48	2.16	2.61
Calcium oxide,	5.90	5.06	4.88	5.35	5.46	4.70	4.86	6.82	6.54	5.40
Magnesium oxide,	1.20	1.61	1.65	1.62	.94	1.02	.95	1.13	1.26	1.63
Ferric & Al. oxide,	.50	.95	.32	.55	.88	.87	.87	.63	.48	.74
Total ash as sulphates	30.72	30.33	27.03	29.73	29.08	28.09	28.97	30.40	29.64	28.83
Sulphuric acid in total ash, less sulphuric acid in plant,	14.17	14.56	13.68	15.04	13.63	12.85	13.26	13.31	15.43	14.32
Silicious material insoluble in diluted hydrochloric acid,	1.97	1.72	1.27	1.92	2.49	1.96	1.91	2.06	2.00	.012

Total ash has been determined as sulphates instead of carbonates for reason stated.

R. H. Smith, Analyst.

SUMMARY OF TOBACCO EXPERIMENT. WESTFIELD.

Number of plants harvested, weight of tobacco per plat, and weight of tobacco per 1000 plants.

	Number of plants per plat.			Weight of tobacco per plat.			Weight of tobacco per 1000 plants.		
	1894	1895	1896	1894	1895	1896	1894	1895	1896
Plat 1,	685	593	677	106	129	141.5	154.8	217.4	209.0
Plat 2,	672	585	692	107	141	147.5	159.3	239.3	213.2
Plat 3,	678	600	705	123	147	145	181.4	245.0	205.8
Plat 4,	667	615	688	128	147	143	192.0	239 0	207.8
Plat 5,	635	580	684	80	94	100.5	126.0	162.0	147.0
Plat 6,	673	594	682	125	141	141.5	185.7	237.3	207.4
Plat 7,	684	605	696	130	145	133	190.1	239.6	191.1
Plat 8,	695	605	701	132	142.5	152	190 0	235.5	216.8
Plat 9,	640	565	685	101.5	138	134.5	158.6	244.2	196.6
Plat 10,	672	590	681	117.5	134.5	135	174.9	228.0	198.2

SUMMARY OF YIELD OF TOBACCO AND PERCENT OF WRAPPER PER 1000 PLANTS. WESTFIELD.

	Tobacco total yield (lbs.)			Wrapper total yield (lbs.)			Per cent of wrapper.		
	1894	1895	1896	1894	1895	1896	1894	1895	1896
Plat 1,	154.8	217.4	209.	66.4	43.8	123.3	42.90	20.15	59.00
Plat 2,	159.3	239.3	213.2	65.5	81.4	143.8	41.60	34.40	67.45
Plat 3,	181.4	245.–	205.8	109.2	65.0	139.1	60.20	26.50	67.80
Plat 4,	192.0	239.–	207.8	119.2	74.	146.7	62.10	30.95	70.63
Plat 5,	126.0	162.–	147.0	61.4	10.4	80.0	48.7	6.39	61.19
Plat 6,	185.7	237.3	207.4	96.6	26.9	163.4	52.0	11.35	78.79
Plat 7,	190.1	239.6	191.1	106.	61.1	120.	55.70	25.60	62.78
Plat 8,	190 0	235.5	216.8	98.	61.9	179.6	51.60	26.31	82.89
Plat 9,	158.6	244.2	196.6	88.2	42.5	138.8	55.60	17.39	70.63
Plat 10,	174.9	228.	198.2	93.	29.5	147.	53.20	13.01	74.70

V. SUMMARY OF THREE YEARS OF OBSERVATION AT HATFIELD, AGAWAM AND WESTFIELD.

1. *Number of Plants Harvested and Yield of Tobacco per One Thousand Plants.*

HATFIELD *(Old tobacco land).*

Year.	Average number of plants.		Difference in yield per plat on the basis of 1000 plants.	
	Per plat.	Per acre.	Highest.	Lowest.
1893	561	6734	266 lbs.	217 lbs.
1894	618	7419	223 "	191 "
1895	626	7512	222 "	191 "
WESTFIELD *(New tobacco land).*				
1894	670	8040	192 lbs.	155 "
1895	593	7122	245 "	217 "
1896	689	8269	216 "	191 "
AGAWAM *(New tobacco land).*				
1893	696	8352	225 lbs.	158 lbs.
1894	704	8432	220 "	164 "
1895	695	8340	222 "	148 "

2. *Average Yield of Tobacco on the Basis of One Thousand Plants Harvested.*

Year.	Hatfield.	Westfield.	Agawam.
1893	235.2	—	191.3
1894	206.4	171.6	186.7
1895	210.5	228	176.2
1896	—	199.4	—

3. *Average Yield of Tobacco, with reference to Wrapper, per One Thousand Plants.*

HATFIELD.

Year.	Average yield of tobacco.	Average yield of wrapper.	Average percentage of wrappers.	Variation in percentage of wrappers in plats.
1893	235.2	97.21	41.2	21 –71
1894	206.6	105	50 7	38.8–64.4
1895	210.1	109.3	52.1	36.8–63.1.

AGAWAM.

Year.	Average yield of tobacco.	Average yield of wrappers.	Percentage of Wrappers	Variation in percentage of wrappers.
1893	190.8	Not determined.	Not determined.	Not determined.
1894	191.7	52.5	26.7	8.8–44.4
1895	178.8	Not determined.	Not determined.	Not determined.

WESTFIELD.

Year.	Average yield of tobacco.	Average yield of wrappers.	Percentage of Wrappers	Variation in percentage of wrappers.
1894	171.3	90.3	52.3	41.6–62.10
1895	228.7	49.6	21.2	6.4–34.40
1896	199.3	138.2	69.6	59–78.8

4. *Conclusions Drawn from the Third Year of Observation.*

1. Good mechanical preparation of the soil and early application and thus good diffusion of the fertilizers, not less than early planting and a suitable number of plants to a given area, exert a decided influence on the quantity and the quality of the crop under other otherwise corresponding conditions. Planting as early as the local climate admits secures the benefit of the winter moisture. Too close planting interferes with a liberal or rapid development of the leaves, and too large open spaces between the individual plants tends to favor a coarser structure. Rows three feet and four inches apart with plants twenty inches from each other in the row (Westfield) and rows two feet and eight inches apart with plants two feet from each other in the row (Hatfield) gave better returns than rows three feet apart with plants eighteen inches from each other in the row (Agawam.

2. A timely *shallow* use of the cultivator or the hoe for the removal of weeds favors a uniform progress of growth. A careless use of cultivator or hoe invariably checks more or less the growth of the plants and modifies more or less their structure and general character.

3. The different fertilizer mixtures used in our experiments have affected in a less marked degree the weight of the crop raised by their aid than the quality. New lands reduced by previous cropping to a state approaching general exhaustion of available plant food —if otherwise well fitted for raising tobacco—have given excellent results when supplied with a suitable mixture of fertilizing ingredients in quantities similar to those applied during our experiments (Westfield.) Such lands are at times preferable to old tobacco lands overcharged with remnants of all kinds of saline ingredients usually associated with the common run of commercial fertilizers.

4. Cotton-seed meal, linseed meal, and castor pomace have proved equally good sources of nitrogen, for the successful raising of tobacco, when used in connection with nitrate of soda or potash, sufficient to furnish one fourth of the nitrogen called for by the crop.

5. Nitrate of soda as part of the nitrogen supply of the fertilizer (25%) when used in presence of acid phosphate or dissolved bone-black, etc., has been accompanied with better results regarding quality of crop than nitrate of potash under otherwise similar conditions.

6. Cotton seed hull ashes and high grade sulphate of potash have proved in our observation most valuable sources of potash for tobacco, the former in the majority of cases leading. Nitrate of potash has produced excellent results when used in connection with an alkaline phosphate as phosphatic slag meal or with carbonate of potash-magnesia. Our results with potash-magnesia sulphate as main potash sources of a tobacco fertilizer are not encouraging.

7. The difference noticed in the color of ash, etc., in case of the crop being raised upon different plats is in several instances so slight that any attempt at classifying the various fertilizers used with reference to their superior fitness cannot be otherwise than somewhat arbitrary. With this qualification in mind, the following classification is offered for the consideration of parties engaged in the cultivation of tobacco in our section of the country :

First class	*Plat 4—Nitrate of soda, cotton seed hull ashes, castor pomace.*
	" 3— " " " " cotton seed meal.
	" 9—Nitrate of potash, cotton seed hull ashes, cotton seed meal.
	" 10—Nitrate of potash, carbonate of potash-magnesia, phosphatic slag.
Second class	*Plat 6—Nitrate of soda, high grade sulphate of potash, cotton seed meal, dissolved bone black.*
	" 8—Nitrate of soda, high grade sulphate of potash, linseed meal, dissolved bone black.
	" 7—Nitrate of soda, high grade sulphate of potash, castor pomace, dissolved bone black.
Third class	*Plat 1—Nitrate of potash, potash-magnesia sulphate, cotton seed meal, dissolved bone black.*
	" 2—Nitrate of potash, potash-magnesia sulphate, castor pomace, dissolved bone black.

The observations with barnyard manure have not been considered in the above classification; they are very encouraging yet not sufficient in number to advise detailed discussion in this connection. Besides, the amount of barnyard manure used in our experiment, 10 tons per acre, contained nearly two hundred pounds of potassium oxide and from thirty to forty pounds of available phosphoric acid less than our formula of commercial fertilizing ingredients called for. An early application of barnyard manure properly supplemented with a suitable potash compound and available phosphoric acid has produced excellent results in other localities.

Amherst, May 12th, 1897.

SPECIAL NOTICE.

Bulletins containing analyses of fertilizers and Annual Reports of the Station will hereafter be sent only to those especially desiring them. If you wish for these, send your name at once to the Director, Hatch Experiment Station, Amherst, Mass. Other bulletins will be sent as at present.

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS

AGRICULTURAL COLLEGE.

BULLETIN NO. 48.

I. ANALYSES OF MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.
II. ANALYSES OF LICENSED FERTILIZERS COLLECTED BY THE AGENT OF THE STATION DURING 1897.

JULY, 1897.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request

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HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are:—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Robert H. Smith, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles I. Goessmann, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Fred W. Mossman, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B. Sc.,	*Assistant Horticulturist.*
Stephen W. Fletcher, B. Sc.,	*Assistant Horticulturist.*
Benjamin K. Jones, B. Sc.,	*Assistant in Foods and Feeding.*
James L. Bartlett, B. Sc.,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

DEPARTMENT OF CHEMISTRY.

C. A. GOESSMANN.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

WOOD ASHES.

295-299. I. Received from North Hatfield, Mass.
II. Received from Concord, Mass.
III. Received from Hadley, Mass.
IV. Received from Lexington, Mass.
V. Received from Concord, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	5.35	10.62	9.92	11.45	20.42
Potassium oxide,	4.48	6.72	4.24	5.60	5.12
Phosphoric acid,	.13	1.02	.70	.26	.51
Calcium oxide,	26.03	30.48	27.68	23.72	19.62
Insoluble matter,	16.42	17.48	7.52	14.84	14.35

300-304. I. Received from Amherst, Mass.
II. Received from Amherst, Mass.
III. Received from Concord, Mass.
IV. Received from Concord, Mass.
V. Received from Concord, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	.72	2.77	2.62	1.33	35.70
Potassium oxide,	5.48	6.48	7.56	8.16	3.80
Phosphoric acid,	1.41	1.22	.77	.13	.08
Calcium oxide,	41.60	43.40	31.18	29.45	30.76
Insoluble matter,	11.05	7.46	9.01	22.07	17.08

305-309. I. Received from Concord, Mass.
II. Received from Boston, Mass.
III. Received from Concord, Mass.
IV. Received from Concord, Mass.
V. Received from Concord, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	15.57	4.85	12.22	15.92	4.35
Potassium oxide,	7.64	5.64	8.16	6.60	7.32
Phosphoric acid,	.13	.26	.06	.06	.06
Calcium oxide,	28.96	38.99	39.14	30.40	32.99
Insoluble matter,	14.80	16.62	14.47	9.52	21.82

310-314. I. Received from Concord, Mass.
II. Received from Concord, Mass.
III. Received from Concord, Mass.
IV. Received from Concord, Mass.
V. Received from North Hadley, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	16.37	13.35	16.32	5.15	2.62
Potassium oxide,	5.92	5.88	7.12	6.52	8.48
Phosphoric acid,	.83	.79	1.07	1.57	.90
Calcium oxide,	*	*	*	*	39.62
Insoluble matter,	15.79	14.44	6.09	11.69	8.48

315-319. I. Received from Concord, Mass.
II. Received from Beverly, Mass.
III. Received from Fitchburg, Mass.
IV. Received from Fitchburg, Mass.
V. Received from Danvers, Mass.

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.42	9.97	8.62	15.00	1.20
Potassium oxide,	6.00	6.92	5.68	6.12	7.20
Phosphoric acid,	.28	1.58	1.66	1.28	2.18
Calcium oxide,	38.43	33.44	37.73	34.84	38.56
Insoluble matter,	13.28	13.21	10.01	10.64	11.69

320-324. I. Received from Amherst, Mass.
II. Received from South Deerfield, Mass.
III. Received from North Sudbury, Mass.
IV. Received from Rock Bottom, Mass.
V. Received from Beverly, Mass.

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*Not determined.

Per cent.

	I.	II.	III.	IV.	V.
Moisture at 100° C.,	13.80	8.57	19.02	21.75	8.31
Potassium oxide,	5.56	5.88	4.64	5·96	7.72
Phosphoric acid,	1.74	1.48	1.58	1.40	1.38
Calcium oxide,	34.60	31.30	31.55	29.49	*
Insoluble matter,	10.00	18.66	11.11	10.93	8.84

325-329. I. Received from Sunderland, Mass.
II. Received from Concord, Mass.
III. Received from Concord, Mass.
IV. Received from Concord, Mass.
V. Received from Concord, Mass.

Per cent.

	I.	II.	III.	IV.	V.
Moisture at 100° C.,	14.45	25.26	11.25	20.52	26.37
Potassium oxide,	6.44	5.24	5.20	5.28	4.36
Phosphoric acid,	1.70	.51	1.88	1.34	.74
Insoluble matter,	10.37	11.91	11.74	15.30	15.69

330-334. I. Received from Concord, Mass.
II. Received from Amherst, Mass.
III. Received from South Lancaster, Mass.
IV. Received from Townsend, Mass.
V. Received from Sunderland, Mass.

Per cent.

	I.	II.	III.	IV.	V.
Moisture at 100° C.,	13.95	14.57	6.07	20.55	15.07
Potassium oxide,	5.96	5.52	6.32	6.40	6.28
Phosphoric acid,	.96	1.34	1.80	1.41	1.60
Calcium oxide,	*	*	36.66	*	29.82
Insoluble matter,	16.32	11.37	15.26	9.31	13.23

335-339. I. Received from Concord, Mass.
II. Received from North Hadley, Mass.
III. Received from North Hatfield, Mass.
IV. Received from North Hatfield, Mass.
V. Received from Chicopee, Mass.

Per cent.

	I.	II.	III.	IV.	V.
Moisture at 100° C.,	24.47	8.55	20.62	1.02	6.95
Potassium oxide,	5.76	5.44	5.84	4.60	5.48
Phosphoric acid,	.97	1.73	.96	.96	1.09
Insoluble matter,	13.89	11.84	13.82	11.43	11.68

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*Not determined.

340-341. I. Received from Amherst, Mass.
II. Received from Westboro, Mass.

	Per cent. I.	Per cent. II.
Moisture at 100° C.,	7.70	13.67
Potassium oxide,	5.44	6.16
Phosphoric acid,	1.41	.70
Calcium oxide,	*	25.25
Insoluble matter,	13.22	15.95

Several of the previously described samples of ashes are reported to be the products of some special local industry, while the remainder are represented as taken from car loads of imported, unleached Canada wood ashes in their respective place of collection.

An examination of our above stated analyses shows the following variations with reference to the amount of potash and phosphoric acid they contain:

			No. of samples.
Potassium oxide	above	8%	3
" "	from	7 to 8%	6
" "	"	6 to 7%	12
" "	"	5 to 6%	20
" "	"	4 to 5%	5
" "	"	3 to 4%	1
" "	below	3%	none.
Phosphoric acid	above	2%	1
" "	from	1 to 2%	23
" "	below	1%	23

Wood ashes ought to be bought and sold on the basis of a guaranteed stated amount of potash and phosphoric acid, naming each ingredient by itself with reference to quantity, as required by our state laws for the regulation of the trade in commercial fertilizers. Some dealers in wood ashes have of late adopted the practice of stating merely the sum of both, instead of specifying the amount of each of them present.

As phosphoric acid and potassium oxide contained in wood ashes are considered in our section of the country, pound for pound of an equal commercial value, from 4.5 to 5 cents, no particular objection can be raised against a joint statement of both as far as the mere money value of the samples is concerned, yet as this mode of stating the guaranteed composition is apt to lead to misconception and abuse, it ought to be discouraged and discontinued.

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*Not determined.

To meet frequent inquiries regarding the amount of moisture and the amount of foreign mineral matter which genuine Canada unleached wood ashes ought to contain, a series of observations have been of late instituted at our laboratory to furnish facts for general information. The results obtained in this connection are as follows:

			No. of samples.
Moisture	from	1 to 3%	7
"	"	4 to 6%	5
"	"	6 to 10%	8
"	"	10 to 15%	11
"	"	15 to 20%	6
"	"	20 to 30%	8
"	above	35	1

		No. of samples.
Mineral matter insoluble in diluted hydrochloric acid from	6 to 10%	8
	10 to 15%	26
	15 to 20%	11
	20 to 30%	2

The variations noticeable in the composition of wood ashes are not surprising when considering the crude mode of collecting and handling them for commercial purposes. The particular effects of both varying quantities of foreign insoluble matter as soil, coal ashes, etc., and of moisture, on the composition of a given sample of genuine wood ashes, as far as its percentage of potash and of phosphoric acid is concerned, depend largely on the particular kind of wood which has served for the production of the ash. The color of the wood ashes in case of dark varieties depends usually on an admixture of more or less charcoal; while an exceptionally light color is not unfrequently due to the kind of wood which furnished it. Some kinds of wood, as elmwood, produce a white ash of excellent quality, judging from samples sent on for examination.

As the dealer is only obliged to guarantee the amount of potash and of phosphoric acid present in a given quantity of wood ashes, no serious objection can be raised on the part of the buyer, on account of moisture, etc., as long as the article contains the specified amount of both potash and phosphoric acid.

Wood ashes ought to be bought and sold by weight and not by measure, for both moisture and foreign matters are apt to affect seriously the weight of a given measure.

LIME-KILN ASHES.

342. I. Received from Boston, Mass.
II. Average analysis of seventeen samples.

	Per cent.	
	I.	II.
Moisture at 100° C.,	34.30	14.40
Potassium oxide,	1.19	1.28
Phosphoric acid,	.63	1.09
Calcium oxide,	25.22	42.57
Insoluble matter,	5.53	7.69

A comparison of the above analyses shows that the sample sent on from Boston does not represent fairly the quality of our current articles of lime-kiln ashes. Good lime-kiln ashes owe their agricultural value mainly to the lime they contain. The amount of potash and phosphoric acid found present is in many instances but little more than many kinds of good limestone contain. The wood ashes form an insignificant part in the majority of samples of lime-kiln ashes. A more liberal use of lime-kiln ashes and articles of a similar character deserves encouragement in connection with the cultivation of clover-like crops. Dealers in refuse lime from lime-kilns will increase their sales by advertising more liberally their goods during autumn and early spring.

COTTON SEED HULL ASHES.

343. Received from Mittineague, Mass.

	Per cent.
Moisture at 100° C.,	5.55
Potassium oxide,	27.36
Phosphoric acid,	8.82
Calcium oxide,	5.88
Insoluble matter,	9.93

GERMAN POTASH SALTS.

344-346. I. Muriate of potash sent on from Hudson, Mass.
II. Sulphate of potash sent on from Southwick, Mass.
III. Kainit sent on from Concord, Mass.

	Per cent.		
	I.	II.	III.
Moisture at 100° C.,	.25	1.05	1.60
Potassium oxide,	51.36	47.96	13.60

GROUND BONE, AND ASHES AND BONE.

347-348. I. Ground bone sent on from Globe Village, Mass.
II. Ashes and bone sent on from Westboro, Mass.

	Per cent.	
	I.	II.
Moisture at 100° C.,	4.67	24.45
Potassium oxide,	—	4.08
Total phosphoric acid,	27.50	4.64
Reverted phosphoric acid,	11.58	2.13
Insoluble phosphoric acid,	16.12	2.51
Nitrogen,	2.05	.72
Insoluble matter,	2.37	*

TANKAGE, AND GROUND MEAT AND BONE.

349-351. I. Tankage sent on from Hudson, Mass.
II. Tankage sent on from Springfield, Mass.
III. Ground meat and bone sent on from Danvers Centre, Mass.

		Per Cent.	
	I.	II.	III.
Moisture at 100° C.,	3.92	5.47	2.07
Nitrogen,	4.74	9.02	5.15
Total phosphoric acid,	18.16	5.65	15.74
Reverted phosphoric acid,	8.06	*	5.50
Insoluble phosphoric acid,	10.10	*	10.24
Potassium oxide,	*	.30	*

MISCELLANEOUS PHOSPHATES.

352-355. I. Hard Florida phosphate.
II. Soft Florida phosphate.
III. Acid phosphate.
IV. South Carolina rock phosphate.

		Per cent.		
	I.	II.	III.	IV.
Moisture at 100° C.,	.65	4.46	18.31	.62
Total phosphoric acid,	33.10	26.48	13.28	25.58
Soluble phosphoric acid,	—	—	11.36	—
Reverted phosphoric acid,	.10	.38	1.92	1.66
Insoluble phosphoric acid,	33.00	26.10	—	23.92

356-359. I. Dissolved bone black.
II. Navassa phosphate.
III. Apatite.
IV. Phosphate sent on from Agawam, Mass.

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*Not determined.

	Per cent. I.	II.	III.	IV.
Moisture at 100° C.,	8.40	5.77	.07	1.80
Total phosphoric acid,	17.14	24.56	37.74	18.16
Soluble phosphoric acid,	9.98	—	—	—
Reverted phosphoric acid,	3.84	1.66	2.18	1.14
Insoluble phosphoric acid,	3.32	22.90	35.56	17.02
Insoluble matter,	*	*	*	34.62

360-363. I. Dissolved bone meal.
II. Steamed bone meal.
III. Raw knuckle bone meal.
IV. Hoof meal.

	Per cent. I.	II.	III.	IV.
Moisture at 100° C.,	4.38	3.72	1.10	4.10
Total phosphoric acid,	16.38	24.82	26.60	.77
Soluble phosphoric acid,	3.70	—	—	—
Reverted phosphoric acid,	9.10	6.02	5.74	—
Insoluble phosphoric acid,	3.58	18.80	20.86	—
Nitrogen,	2.21	3.73	3.87	15.19

The above articles were secured from reputable dealers and analysed previous to their use for field experiments. The analyses may prove of interest to others, representing a great variety of phosphoric acid resources for manurial purposes.

COTTON SEED MEAL.

364-367. I. Received from Westfield, Mass.
II. Received from North Hadley, Mass.
III. Received from North Hadley, Mass.
IV. Received from North Hadley, Mass.

	Per cent. I.	II.	III.	IV.
Moisture at 100° C.,	5.15	6.60	7.25	6.37
Nitrogen.	7.28	7.48	7.87	8.19

368-371. I. Received from Sunderland, Mass.
II. Received from Springfield, Mass.
III. Received from Loudville, Mass.
IV. Received from Loudville, Mass.

	Per cent. I.	II.	III	IV.
Moisture at 100° C.,	6.65	5.82	3.97	7.37
Nitrogen,	7.33	7.53	6.95	7.62

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*Not determined.

372-376. I. Received from North Hadley, Mass.
II. Received from Sunderland, Mass.
III. Received from Montague, Mass.
IV. Received from North Westport, Mass.
V. Received from Springfield, Mass.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	6.70	7.12	9.85	6.87	6.62
Nitrogen,	7.56	7.45	3.82	7.48	7.62
Potassium oxide,	1.41	1.47	1.58	1.81	1.89
Phosphoric acid,	2.64	2.64	2.23	2.85	2.86

The results of our analyses confirm our previous observations; cotton seed meal ought to be bought on the basis of a guaranteed composition with reference to its nitrogen in particular.

TOBACCO REFUSE.

377-378. I. Tobacco dust sent on from Hatfield, Mass.
II. Ground tobacco stems sent on from Hatfield, Mass.

	Per cent.	
	I.	II.
Moisture at 100° C.,	5.05	8.40
Nitrogen,	2.08	2.23
Potassium oxide,	2.07	6.10
Phosphoric acid,	.42	.32

The composition of the above articles varies often widely; they ought to be bought on a guarantee of nitrogen and potash in particular. Both ingredients are readily available for plant growth.

MUCK AND SOIL.

379-380. I. Received from Boston, Mass.
II. Received from Plymouth, Mass.

	Per cent.	
	I.	II.
Moisture at 100° C.,	81.00	7.65
Organic matter,	15.04	9.72
Ash,	3.96	82.63
Nitrogen,	.44	.26
Phosphoric acid,	.05	Trace
Calcium oxide,	*	Trace
Insoluble matter	*	80.23

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*Not determined.

COMPOUND FERTILIZERS.

381-385. I. Complete fertilizer sent on from Boston, Mass.
II. Compound fertilizer sent on from New Bedford, Mass.
III. Mixed fertilizer, grass formula sent on from North Leominster, Mass.
IV. Mixed fertilizer, potato formula sent on from North Leominster, Mass.
V. Potato manure sent on from Westborough, Mass.

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.07	8.30	10.93	8.95	9.84
Nitrogen,	2.74	.27	3.43	3.37	3.62
Potassium oxide,	5.23	.26	8.30	10.84	10.24
Total phosphoric acid,	15.22	.38	8.82	7.82	8.14
Soluble phosphoric acid,	.06	—	1.16	3.94	1.74
Reverted phosphoric acid,	6.72	.38	5.92	3.02	4.94
Insoluble phosphoric acid,	8.44	—	1.74	.86	1.46
Calcium oxide,	*	13.28	*	*	*
Insoluble matter,	*	58.13	*	*	*

386-390. I. Corn manure sent on from Westborough, Mass.
II. Top-dressing sent on from Westborough, Mass.
III. Fertilizer sent on from East Holliston, Mass.
IV. Blood, Bone and Potash sent on from South Framingham, Mass.
V. Vegetable, Vine and Tobacco fertilizer sent on from Southwick, Mass.

			Per cent.		
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.10	9.67	5.01	6.91	10.57
Nitrogen,	3.44	5.12	2.01	4.56	2.43
Potassium oxide,	7.24	7.14	12.74	7.76	6.56
Total phosphoric acid,	10.74	12.18	10.18	11.12	9.62
Soluble phosphoric acid,	7.78	3.96	—	5.38	5.40
Reverted phosphoric acid,	.74	6.36	4.86	4.08	1.90
Insoluble phosphoric acid,	2.22	1.86	5.32	1.66	2.32

391-395. I. Special fertilizer sent on from Chicopee, Mass.
II. Special fertilizer sent on from Chicopee, Mass.
III. Special fertilizer sent on from Chicopee, Mass.
IV. Tobacco fertilizer sent on from Chicopee, Mass.
V. Fruit and Vine fertilizer sent on from Stowe, Mass.

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*Not determined.

	Per cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	9.40	9.15	9.63	6.25	7.08
Nitrogen,	4.54	5.10	4.83	4.53	1.39
Potassium oxide,	10.90	5.68	11.54	10.60	13.26
Total phosphoric acid,	8.24	16.42	11.54	15.02	8.57
Soluble phosphoric acid,	4.98	8.44	10.14	—	.67
Reverted phosphoric acid,	1.72	7.72	1.38	4.68	5.98
Insoluble phosphoric acid,	1.54	.26	.02	10.34	1.92

396. DAMARALAND GUANO.

	Per cent.
Moisture at 100° C.,	17.70
Organic matter,	25.63
Total ash,	56.67
Total nitrogen,	5.79
Nitrogen in form of ammoniates,	1.80
Nitrogen in form of nitrates,	.05
Nitrogen in form of organic matter,	3.94
Carbonic acid,	Trace
Total phosphoric acid.	14.78
Soluble phosphoric acid,	4.90
Reverted phosphoric acid,	5.79
Insoluble phosphoric acid,	4.09
Total potassium oxide,	3.53
Potassium oxide soluble in water,	3.46
Sodium oxide,	7.03
Calcium oxide,	14.21
Magnesium oxide,	2.05
Iron and aluminium oxides,	Trace
Sulphuric acid,	5.94
Chlorine,	5.77
Insoluble matter,	9.26

The results of our analysis are fairly within the stated composition of the sample (200 pound bag) kindly sent on for trial by Messrs. H. J. Baker & Bro., of New York. The Guano, it is stated has been brought from some islands off the west coast of Africa ; it is a valuable material, as may be seen from our detailed analysis.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
1	Improved Superphosphate,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amherst.
13	Ammoniated Bone and Potash,	Armour & Co., Chicago, Ill.,	Amherst.
14	Bone, Blood and Potash,	Armour & Co., Chicago, Ill.,	Amherst.
19	Bone Fertilizer for Corn and Grain,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
28	Ammoniated Bone and Potash,	Armour & Co., Chicago, Ill.,	New Bedford.
35	X. L. Superphosphate,	Bradley Fertilizer Co., Boston, Mass.,	Amherst.
38	Dry Ground Fish Guano,	Wilcox Fertilizer Works, Mystic, Conn.,	Amherst.
45	Gardeners' Complete Manure,	Packer's Union Fertilizer Co., New York, N. Y.,	Amherst.
53	Complete Manure for Potatoes and Vegetables,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
56	Stockbridge's Complete Manure for Corn and Grain,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
57	Hill and Drill Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
59	Stockbridge's Complete Manure for Top Dressing,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
72	X. L. Superphosphate,	Bradley Fertilizer Co., Boston, Mass.,	Easthampton.
104	Bone, Blood and Potash,	Armour & Co., Chicago, Ill.,	Springfield.
121	X. L. Superphosphate,	Bradley Fertilizer Co., Boston, Mass.,	Beverly.
180	Stockbridge's Complete Manure for Potat's and Vegetab's	Bowker Fertilizer Co., Boston, Mass.,	Beverly.
193	Bone Fertilizer for Corn and Grain,	Lowell Fertilizer Co., Lowell, Mass.,	Lowell.
246	Ammoniated Bone and Potash,	Armour & Co., Chicago, Ill.,	Taunton.
260	Ammoniated Bone and Potash,	Armour & Co., Chicago, Ill.,	Springfield.
288	Bone Fertilizer for Corn and Grain,	Lowell Fertilizer Co., Lowell, Mass.,	Springfield.
382	Gardeners' Complete Manure,	Packer's Union Fertilizer Co., New York, N. Y.,	Westfield.
387	Gardeners' Complete Manure,	Packer's Union Fertilizer Co., New York, N. Y.,	Stowe.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
1	Improved Superphosphate,	14.43	1.31	.82-1.65	7.50	1.64	1.92	11.06	12-14	9.14	10-11	2.48	1-2
13-28-246-260	Ammoniated Bone and Potash,	8.25	2.64	2.47-3.30	4.47	3.81	2.56	10.84	8-10	8.28	6-8	2.38	2-3*
14-104	Bone, Blood and Potash,	6.91	4.56	4.12-4.94	5.38	4.08	1.66	11.12	10-12	9.46	8-10	7.76	7-8*
19-193-288	Bone Fertilizer for Corn and Grain,	7.78	1.75	1.65-2.50	4.40	3 48	2.04	9.92	9-10	7.88	8-10	3.10	3-4
35-72-121	X. L. Superphosphate,	12.85	2.61	2.50-3.25	5.86	2.10	2.92	10.88	11-14	7.96	9-11	2.14	2-3
38	Dry Ground Fish Guano,	7.32	8.59	8.40-10.	—	4.18	3.32	7.50	6-9	4.18	4-8	—	—
45-382-387	Gardeners' Complete Manure,	7 89	2.70	2·47-3.29	6.14	2.38	2.69	11.21	10-15	8.52	8-12	10.16	10-12
53-180	Complete Manure for Potatoes and Veg'bles,	9.84	3.62	3.25-4.25	1.74	4.94	1.46	8.14	8-10	6.68	5-7	10.24	10-12
56	Complete Manure for Corn and Grain,	12.10	3.44	3-4	7.78	.74	2.22	10.74	10-12	8.52	7-9	7.24	6-7
57	Hill and Drill Phosphate,	14.67	2.81	2.50 3.50	7.42	1.76	1.46	10.64	12-13	9.18	9-11	2.40	2-3
59	Complete Manure for Top-dressing,	9.67	5.12	5-6	3.96	.27	1.86	6.09	6-7	4.13	4-6	7.14	6-7

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
71	Fish and Potash,	Quinnipiac Co., Boston, Mass.,	Easthampton.
76	Oats and Top-dressing,	Rogers & Hubbard Co., Middletown, Conn.,	Easthampton.
81	High Grade Special.	Williams & Clark Fertilizer Co., Boston, Mass.,	Easthampton.
82	Complete Manure for Potatoes and Root Crops,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
90	Tobacco Fertilizer,	W. H. Abbott, Holyoke, Mass.,	Holyoke.
94	Special Potato Manure,	Pacific Guano Co., Boston, Mass.,	S. Hadley Falls
101	Oats and Top Dressing,	Rogers & Hubbard Co., Middletown, Conn.,	Holyoke.
102	Soluble Potato Manure,	Rogers & Hubbard Co., Middletown. Conn.,	Holyoke.
110	Crocker's Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Greenfield.
115	Tobacco Manure (Wrapper Brand),	Mapes Formula and Peruvian Guano Co., New York,	Greenfield.
120	Farmers' Friend Superphosphate,	Read Fertilizer Co., New York, N. Y.,	Amesbury.
139	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt.,	North Hadley.
146	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
165	Quinnipiac Phosphate,	Quinnipiac Co., Boston, Mass.,	Plymouth.
189	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Co., Rutland, Vt,,	Chelmsford.
229	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	New Bedford.
235	Quinnipiac Phosphate,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
242	Quinnipiac Phosphate,	Quinnipiac Co., Boston, Mass.,	Taunton.
275	High Grade Special,	Williams & Clark Fertilizer Co., Boston, Mass.,	Gr. Barrington
297	Tobacco Fertilizer,	W. H. Abbott, Holyoke, Mass.,	Amherst.
300	Special Potato Manure,	Pacific Guano Co., Boston, Mass.,	S. Williamsto'n
303	Quinnipiac Phosphate,	Quinnipiac Co., Boston, Mass.,	Williamstown.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
71	Fish and Potash, ...	18.07	2.42	2.06-2.89	1.07	3.82	2.56	7.45	6-9	4.89	4-7	4.22	4-6
76-101	Oats and Top-dressing, ...	3.96	8.92	8.80-9.70	—	2.30	6.32	8.62	7.85-8.75	2.30	—	9.10	8.35-9.25
81-275	High Grade Special, ...	10.81	3.57	3.70-4.12	4.98	3.72	1.36	10.06	8-10	8.70	7-9	6.92	7-9
82	Complete Manure for Potat. and Root Crops,	5.78	4.00	3.30-4.12	2.90	2.44	7.04	12.38	8-10	5.34	5-6	8.34	7-9*
90-297	Tobacco Fertilizer, ...	6.25	4.53	4.5-5.5	—	4.68	10.34	15.02	17-18	4.68	—	10.60	10-11*
94-300	Special Potato Manure, ...	9.81	2.71	2.47-3.30	4.14	1.12	2.04	7.30	7-10	5.26	5-7	5.02	5-6
102	Soluble Potato Manure, ...	8.96	5.34	5.-6.60	.90	5.58	4.18	10.66	10-12	6.48	—	6.06	5-6*
110	Crocker's Ammoniated Bone Superphosph.,	8.13	3.03	2.90-3.70	7.30	2.10	1.94	11.34	11-14	9.40	10-12	1.08	1.08-2.00
115	Tobacco Manure (Wrapper Brand), ...	4.97	6.50	6.18	—	4.88	1.08	5.96	4.50	4.88	—	9.90	10.50*
120	Farmers' Friend Superphosphate, ...	13.04	2.14	2-3	2.94	7.08	.98	11.00	10-12	10.02	9-11	2.32	2-4
139-189	Vegetable, Vine and Tobacco Fertilizer, ...	10.57	2.43	2.06-3.00	5.40	1.90	2.32	9.52	9-15	7.30	8-12	6.56	6-8
146-226	A. A. Ammoniated Superphosphate, ...	13.49	2.95	2.47-3.25	7.30	3.10	1.04	11,44	11-13	10.40	10-12	2.76	2-3
165-235-242-303	Quinnipiac Phosphate, ...	12.03	2,82	2.47-3.30	5.76	2.30	3.46	11.52	10-14	8.06	9-12	3.02	2-3

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Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
170	Special Formula,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Leverett,
173	Essex XXX Fish and Potash,	Russia Cement Co., Gloucester, Mass.,	Beverly.
178	Special Potato Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Beverly.
192	Celebrated Potato Special,	E. Frank Coe., Co., New York, N. Y.,	Chelmsford.
199	Essex XXX Fish and Potash,	Russia Cement Co.. Gloucester, Mass.,	Athol.
215	Special Formula,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Sunderland.
216	General American Fertilizer for all Crops,	American Fertilizer Co., Boston, Mass.,	Dartmouth.
220	Standard Superphosphate,	Read Fertilizer Co., New York, N. Y.,	Amesbury.
222	Guano,	Cumberland Bone Phosphate Co., Boston, Mass.,	North Adams.
234	Guano,	Cumberland Bone Phosphate Co., Boston, Mass.,	Housatonic,
250	High Grade Fertilizer.	Bowker Fertilizer Co., Boston, Mass.,	Beverly.
268	Ward's Chemical Fertilizer,	Andrew D. Ward, Boston, Mass.,	Amherst.
279	Columbian Phosphate,	The Berkshire Mills, Bridgeport, Conn.,	Gr. Barrington
334	Essex XXX Fish and Potash,	Russia Cement Co., Gloucester, Mass.,	Palmer.
339	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Fitchburg.
362	High Grade Fertilizer,	Bowker Fertilizer Co., Boston. Mass ,	Fitchburg.
369	Tobacco Grower,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Westfield.
371	High Grade Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Spencer.
376	Great Planet Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Westfield.
380	Potato Manure,	J. G. Jefferds, Worcester, Mass.,	Worcester.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
170-215	Special Formula,	9.05	4.17	4-5	1.74	4.84	3.20	9.78	8-11	6.58	6-8	10.30	10-11
173-199-334	Essex XXX Fish and Potash,	7.73	2.47	2.10-3.00	2.81	6.53	5.88	15.22	12-14	9.34	10-11	2.44	2.25-3.25
178	Special Potato Fertilizer,	7.20	3.75	3.29-4.12	3.84	5.76	2.30	11.90	9-13	9.60	8-11	7.80	7-9
192	Celebrated Potato Special,	9.79	1.79	1.65-2.45	5.76	3.40	2.48	11.64	11-13	9.16	9-12	3.92	3.50-4.00*
216	General American Fertilizer for all Crops,	9.06	1.97	1.65-2.47	—	5.50	8.19	13.69	9-10	5.50	6-7	2.14	2-3
220	Standard Superphosphate,	14.70	1.08	.83-1 00	6.14	1.74	1.46	9.34	9-11	7.88	8-10	4.04	4-6
222-234	Guano,	12.80	1.10	1.03-2.05	4.60	3.72	1.92	10.24	10-13	8.32	8-10	2.18	2-3
250-262-371	High Grade Fertilizer,	13.11	2.57	2.25-3.25	7.93	.29	2 30	10.52	10-13	8.22	8-10	4.10	4-6
268	Ward's Chemical Fertilizer,	2.90	5.54	5.50-6.00	—	17.76	—	17.76	17-17.50	17.76	17-17.50	—	—
279	Columbian Phosphate,	10.45	1.80	.82-1.65	1.40	5.76	4.48	11.64	10-12	7.16	8-10	1.72	1-2
339	Vegetable Bone Superphosphate,	11.61	5.10	5-6	4.74	.68	1.16	6.58	6-7	5.42	5.50-7	6.28	5.94-8.00
369	Tobacco Grower,	10.01	4.87	4.94-5.77	2.97	3.82	3.39	10.18	10-12	6.79	7-9	10.02	10-11
376	Great Planet Fertilizer,	11.78	3.43	3.30-4.12	4.92	2.80	1.74	9.46	9-13	7.72	8-11.50	6.84	7-8
380	Potato Manure,	9.70	2.14	3-4.75	4.61	5.80	5.45	15.86	15-17	10.41	10-12	6.92	5-6

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Chemicals.		
34	Muriate of Potash,	Lucien Sanderson, New Haven, Conn,,	Sunderland.
48	Sulphate of Potash,	Williams & Clark Fertilizer Co., Boston, Mass.,	Northampton.
50	Muriate of Potash,	Williams & Clark Fertilizer Co., Boston, Mass.,	Northampton.
60	Dissolved Bone Black,	Bowker Fertilizer Co., Boston. Mass.,	Northampton.
64	Nitrate of Soda,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
65	Sulphate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
66	Muriate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
67	Sulphate of Ammonia,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
68	High Grade Sulphate of Potash,	Bowker Fertilizer Co., Boston, Mass.,	Northampton.
77	Muriate of Potash,	Quinnipiac Co., Boston, Mass.,	Southampton.
78	Nitrate of Soda,	Quinnipiac Co., Boston, Mass.,	Southampton.
80	Sulphate of Ammonia,	Quinnipiac Co., Boston, Mass.,	Southampton.
85	High Grade Sulphate of Potash,	Prentiss, Brooks & Co., Holyoke Mass.,	Holyoke.
89	Nitrate of Soda,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
155	Dissolved Bone Black,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
255	Nitrate of Soda,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
267	Sulphate of Ammonia,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
335	High Grade Sulphate of Potash,	Quinnipiac Co., Boston, Mass.,	Fitchburg.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Chemicals.												
34	Muriate of Potash, ...	.92	–	–	–	–	–	–	--	–	--	51.60	50.54-53.65
48	Sulphate of Potash, ...	5.22	–	–	–	–	–	–	--	–	--	28.12	25.93-28.10
50	Muriate of Potash, ...	.92	–	–	–	–	–	–	--	–	--	51.60	50.54-53.65
60	Dissolved Bone Black, ...	13.85	–	–	14.08	1.79	.13	16.00	16-20	15.87	15-18	--	--
64	Nitrate of Soda, ...	1.55	15.85	12.36-14.83	–	–	–	–	--	-	--	--	--
65	Sulphate of Potash, ...	5.22	–	–	–	–	–	–	--	–	--	28.12	25.93-28.10
66	Muriate of Potash, ...	.82	–	–	–	–	–	–	--	–	--	51.60	50.54-53.65
67	Sulphate of Ammonia, ...	1.82	19.79	19.79-20.60	–	–	–	–	--	–	--	--	--
68	High Grade Sulphate of Potash, ...	.62	–	–	–	–	–	–	--	–	--	51.84	48-52
77	Muriate of Potash, ...	.92	–	–	–	–	–	–	--	–	--	51.60	50.54-53.64
78	Nitrate of Soda, ...	1.32	16.01	15.48-15.81	–	–	–	–	--	–	--	--	--
80	Sulphate of Ammonia, ...	1.67	20.62	20.38-20.80	–	–	–	–	--	–	--	--	--
85	High Grade Sulphate of Potash, ...	.60	–	–	–	–	–	–	--	–	--	51.09	48-52
89	Nitrate of Soda, ...	1.32	16.01	15.48-15.81	–	–	–	–	--	–	--	--	--
155	Dissolved Bone Black, ...	13.85	–	–	14.08	1.79	.13	16.00	16-20	15.87	15-18	--	--
255	Nitrate of Soda, ...	1.47	15.64	15.64-16.48	–	–	–	–	--	–	--	--	--
267	Sulphate of Ammonia, ...	1 85	19.97	19.79-20.60	–	–	–	–	--	–	--	--	--
335	High Grade Sulphate of Potash, ...	.60	–	–	–	–	–	–	--	–	--	51.09	48.63-51.34

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Ground Bones.		
36	Fine Ground Bone,	Bradley Fertilizer Co., Boston, Mass.,	Amherst.
118	Fine Ground Bone,	Thomas Hersom, New Bedford, Mass.,	Amherst.
219	Fine Ground Bone,	Bradley Fertilizer Co., Boston, Mass.,	Haverhill.
291	Pure Ground Bone,	Bartlett & Holmes, Springfield, Mass.,	Springfield.
373	Pure Ground Bone.	C. A. Bartlett, Worcester, Mass.,	Worcester.
	Chemicals.		
79	Dissolved Bone Black,	Quinnipiac Co., Boston, Mass.,	Southampton.
95	Nitrate of Soda,	Bradley Fertilizer Co., Boston, Mass.,	Holyoke.
96	Muriate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Holyoke.
135	Muriate of Potash,	National Fertilizer Co,, Bridgeport, Conn.,	Sunderland.
137	Sulphate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
159	Nitrate of Soda,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
161	Muriate of Potash,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
254	Dissolved Bone Black,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
256	Sulphate of Potash,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
257	Nitrate of Soda,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
258	Muriate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
262	Sulphate of Potash,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
264	Dissolved Bone Black,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
293	Nitrate of Soda,	Lowell Fertilizer Co., Lowell, Mass.,	Springfield.
340	Dissolved Bone Black,	Quinnipiac Fertilizer Co., Boston, Mass.,	Fitcburg.
342	High Grade Sulphate of Potash,	Bradley Fertilizer Co., Boston, Mass.,	Worcester.
345	Nitrate of Soda,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Fitchburg.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Mechanical Analysis.				Potassium Oxide in 100 lbs.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total.		Available.		Fine.	Fine Med.	Medium.	Coarse Medium.	Found.	Guaranteed.
								Found.	Guaran-teed.	Found.	Guaran-teed.						
	Ground Bones.																
36-219	Fine Ground Bone,	7.32	2.96	2.50-3.25	—	6.22	13.02	19.24	21-23	6.22	—	63.10	18.66	15.99	2.25		
118	Fine Ground Bone,	3.99	2.29	—	.28	4.69	19.16	24.12	—	4.97	—	52.68	28.02	16.72	2.58		
291	Pure Ground Bone,	4.02	2.54	2-3	—	8.62	17.48	26.10	27-29	8.62	—	46.63	28.58	23.83	.96		
373	Pure Ground Bone,	3.88	2.39	2-3	—	9.60	17.24	26.84	27-29	9.60	—	83.36	15.05	1.59	—		
	Chemicals.																
95	Nitrate of Soda,	1.32	16.01	15.48-15.81	—	—	—	—	—	—	—					—	—
96	Muriate of Potash,	.92	—	—	—	—	—	—	—	—	—					51.60	50.24-53.65
135-258	Muriate of Potash,	.92	—	—	—	—	—	—	—	—	—					51.60	50.54-53.65
159	Nitrate of Soda,	1.32	16.01	15.48-15.81	—	—	—	—	—	—	—					—	—
161	Muriate of Potash,	.92	—	—	—	—	—	—	—	—	—					51.60	50.54-53.65
254	Dissolved Bone Black,	13.85	—	—	14.08	1.79	.13	16.00	16-20	15.87	16-18					—	—
256	Sulphate of Potash,	5.22	—	—	—	—	—	—	—	—	—					28.12	27.02
257	Nitrate of Soda,	1.47	15.64	15.64	—	—	—	—	—	—	—					—	—
137-262	Sulphate of Potash,	5.22	—	—	—	—	—	—	—	—	—					28.12	27.02-29.72
264	Dissolved Bone Black,	13.85	—	—	14.08	1.79	.13	16.00	—	15.87	16-18					—	—
293	Nitrate of Soda,	1.62	15.79	15.24	—	—	—	—	—	—	—					—	—
79-340	Dissolved Bone Black,	13.85	—	—	14.08	1.79	.13	16.00	—	15.87	15-18					—	—
342	High Grade Sulphate of Potash,	.57	—	—	—	—	—	—	—	—	—					50.34	48.63-51.34
345	Nitrate of Soda,	1.62	15.79	15.24	—	—	—	—	—	—	—					—	—

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, B. Sc.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles I. Goessmann, B. Sc.,	*Assistant Chemist* (Fertilizers).
George D. Leavens, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Fred W. Mossman, B. Sc.,	*Ass't Chemist*(Foods and Feeding).
Benjamin K. Jones, B. Sc.,	*Assistant in Foods and Feeding.*
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
G. A. Drew, B. Sc.,	*Assistant Horticulturist.*
H. D. Hemenway, B. Sc.,	*Assistant Horticulturist.*
H. H. Roper, B. Sc.,	*Assistant in Foods and Feeding.*
A. C. Monahan,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

DEPARTMENT OF CHEMISTRY.

C. A. Goessmann.

I.

ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.

397—400. WOOD ASHES.

I. Received from Northfield, Mass.
II. Received from Northfield, Mass.
III. Received from South Deerfield, Mass.
IV. Received from South Amherst, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	3.75	2.24	7.55	9.97
Potassium oxide,	7.31	6.71	6.20	4.74
Phosphoric acid,	1.35	2.35	0.97	1.53
Calcium oxide,	42.60	29.57	45.47	36.98
Insoluble matter,	10.46	22.87	6.55	16.57

401—404. I. Received from Amherst, Mass.
II. Received from North Hadley, Mass.
III. Received from Malden, Mass.
IV. Received from Taunton, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	9.00	15.48	.005	15.86
Potassium oxide,	5.12	3.85	6.03	5.35
Phosphoric acid,	1.35	1.28	1.58	1.28
Calcium oxide,	35.50	39.50	50.58	34.60
Insoluble matter,	15.02	8.49	16.71	13.47

405—408. I. Received from Sunderland, Mass.
II. Received from North Amherst, Mass.
III. Received from Westboro, Mass.
IV. Received from Sunderland, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	7.57	11.20	12.28	10.73
Potassium oxide,	5.48	5.28	5.54	5.79
Phosphoric acid,	1.69	1.74	1.07	1.23
Calcium oxide,	36.49	39.46	23.64	33.86
Insoluble matter,	14.54	10.56	35.67	16.12

409—412. I. Received from Leverett, Mass.
II. Received from Sunderland, Mass.
III. Received from Hadley, Mass.
IV. Received from Sunderland, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	10.98	14.07	5.15	18.26
Potassium oxide,	7.86	6.28	6.66	6.28
Phosphoric acid,	1.48	1.60	2.20	1.02
Calcium oxide,	21.01	29.82	36.60	34.47
Insoluble matter,	28.27	13.23	23.80	14.40

413—417. I. Received from Concord, Mass.
II. Received from Swansea Centre, Mass.
III. Received from Hadley, Mass.
IV. Received from North Westport, Mass.
V. Received from North Amherst, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	14.03	20.24	20.45	19.32	5.37
Potassium oxide,	6.32	6.80	4.40	4.64	4.88
Phosphoric acid,	1.09	1.25	2.35	1.30	1.37
Calcium oxide,	29.33	31.80	32.04	32.54	*
Insoluble matter,	31.80	37.81	24.07	13.95	12.38

418—422. I. Received from North Amherst, Mass.
II. Received from South Amherst, Mass.
III. Received from North Hatfield, Mass.
IV. Received from Fitchburg, Mass.
V. Received from Sunderland, Mass.

	Per Cent.				
	I.	*II.*	*III.*	*IV.*	*V.*
Moisture at 100° C.,	12.80	19.18	9.83	14.40	5.70
Potassium oxide,	5.28	3.97	4.36	5.02	6.60
Phosphoric acid,	1.25	1.28	1.40	1.59	1.02
Calcium oxide,	*	36.45	38.26	31.64	44.49
Insoluble matter,	12.20	10.06	22.90	41.39	17.01

423—424. COTTON SEED MEAL.

I. Received from Springfield, Mass.
II. Received from Sunderland, Mass.

	Per Cent.	
	I.	*II.*
Moisture at 100° C.,	7.50	10.83
Nitrogen,	7.34	3.24
Potassium oxide,	1.50	1.58
Phosphoric acid,	1.71	2.23

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* Not determined.

425—426. TANKAGE.

I. Received from Rock Bottom, Mass.
II. Received from West Springfield, Mass.

	Per Cent. *I.*	*II.*
Moisture at 100° C.,	10.99	16.30
Nitrogen,	5.03	7.05
Total phosphoric acid,	13.36	11.39
Reverted phosphoric acid,	9.96	3.61
Insoluble phosphoric acid,	3.40	7.78

427—430. GROUND BONE AND DRY FISH.

I. Ground bone received from Rock Bottom, Mass.
II. Ground bone received from Amesbury, Mass.
III. Ground bone received from Northboro, Mass.
IV. Dry ground fish received from Rock Bottom, Mass.

		Per Cent.		
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	4.00	5.39	4.40	7.96
Nitrogen,	2.84	3.09	3.85	7.69
Total phosphoric acid,	20.90	25.71	24.70	7.08
Reverted phosphoric acid,	13.35	5.65	5.90	3.48
Insoluble phosphoric acid,	7.55	20.06	18.80	3.60

COTTON WASTE, HOP REFUSE AND SPENT BREWER'S GRAIN.

431—433. I. Cotton waste received from Amesbury, Mass.
II. Hop refuse received from Sunderland, Mass.
III. Spent brewer's grain from Sunderland, Mass.

		Per Cent.	
	I.	*II.*	*III.*
Moisture at 100° C.,	27.02	85.20	73.10
Nitrogen,	.84	.691	1.23
Potassium oxide,	.52	.06	.07
Phosphoric acid,	.74	.10	.33

434—439. MUCK, COMPOST, SOIL AND LOAM.

I. Soil received from Hopkinton, Mass.
II. Soil received from Boston, Mass.
III. Loam received from Boston, Mass.
IV. Muck received from Brookline, Mass.
V. Muck received from Brookline, Mass.
VI. Compost received from Palmer, Mass.

	Per Cent.					
	I.	*II.*	*III.*	*IV.*	*V.*	*VI.*
Moisture at 100° C.,	80.86	4.37	1.78	75.91	95.38	1.70
Ash,	5.41	74.54	88.88	11.18	*	*
Nitrogen,	.38	.38	.15	.30	.92	.79
Phosphoric acid,	trace,	trace,	trace,	trace,	trace,	.56
Calcium oxide,	trace,	.38	trace,	trace,	trace.	*
Potassium oxide,	*	*	*	*	*	.97

440. SHEEP MANURE.

Received from Sunderland, Mass.

	Per Cent.
Moisture at 100° C.,	15.60
Nitrogen,	.85
Potassium oxide,	.68
Phosphoric acid,	.22
Insoluble matter,	63.39

441—443. SULPHATE OF AMMONIA.

I. Received from Amesbury, Mass.
II. Received from Fitchburg, Mass.
III. Received from Fitchburg, Mass.

	Per Cent.		
	I.	*II.*	*III.*
Moisture at 100° C.,	1.78	.45	.17
Nitrogen,	20.16	20.89	21.22

444—445. NITRATE OF SODA.

I. Received from Amesbury, Mass.
II. Received from Fitchburg, Mass.

	Per Cent.	
	I.	*II.*
Moisture at 100° C.,	1.41	1.70
Nitrogen.	15.87	16.08

SULPHATE OF POTASH AND MURIATE OF POTASH.

446—448.

I. Sulphate of potash, received from Rock Bottom, Mass.
II. Sulphate of potash, received from Fitchburg, Mass.
III. Muriate of potash, received from Amesbury, Mass.

	Per Cent.		
	I.	*II.*	*III.*
Moisture at 100° C.,	2.40	.87	.92
Potassium oxide,	51.96	46.84	51.60

* Not determined.

SOUTH CAROLINA ROCK PHOSPHATE AND ACID PHOSPHATES.

449—451.

I. So.Carolina rock phosphate, received from So.Sandisfield, Mass.
II. Acid phosphate, received from Amesbury, Mass.
III. Acid phosphate, received from Amesbury, Mass.

	Per Cent		
	I	*II.*	*III.*
Moisture at 100° C.,	1.06	7.36	9.32
Total phosphoric acid,	31.78	17.48	13.43
Soluble phosphoric acid,	—	2.02	6.01
Reverted phosphoric acid,	*	6.71	5.87
Insoluble phosphoric acid,	*	8.75	1.55

452—458. COMPLETE FERTILIZERS.

I. Scientific potato fertilizer, received from Milford, Mass.
II. Compound fertilizer No. I., received from Swansea Centre, Mass.
III. Comp. fertilizer No. II, received from Swansea Centre, Mass.
IV. Hatch Special, received from Amesbury, Mass.
V. Top dressing, received from Amesbury, Mass.
VI. Lavery's fertilizer, received from Amesbury, Mass.
VII. Complete root manure, received from Sunderland, Mass.

	Per Cent.			
	I.	*II.*	*III.*	*IV.*
Moisture at 100° C.,	7.39	12.80	12.88	17.80
Nitrogen,	1.87	4.05	3.01	4.10
Potassium oxide,	5.21	11.59	11.74	8.11
Total phosphoric acid,	12.74	7.47	8.32	8.60
Soluble phosphoric acid,	8.49	2.75	5.12	—
Reverted phosphoric acid,	2.10	2.88	1.46	4.66
Insoluble phosphoric acid,	2.15	1.84	1.74	3.94

	Per Cent		
	V.	*VI.*	*VII.*
Moisture at 100° C.,	10.42	9.97	13.37
Nitrogen,	4.32	1.91	2.22
Potassium oxide,	9.74	1.41	12.02
Total phosphoric acid,	10.21	5.68	11.13
Soluble phosphoric acid,	1.36	.51	6.63
Reverted phosphoric acid,	6.73	3.76	2.33
Insoluble phosphoric acid,	2.12	1.41	2.17

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

LABORATORY No.	NAME OF BRAND	NAME OF MANUFACTURER.	SAMPLED AT
	Compound Fertilizers.		
2	Farmer's Choice Bone Phosphate,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amherst.
3	Potato and Tomato Manure,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amherst.
4	Tobacco Fertilizer,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amherst.
5	Martin's Bone Mixture,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amherst.
6	Normal Bone Phosphate,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amheret.
7	S. C. Phosphate,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amherst.
8	S. C. Phosphate with Potash, 2 per cent.,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amherst.
17	Champion Fertilizer,	D. Whithed, Lowell, Mass.,	Amherst.
20	Animal Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
21	Complete Potato and Vegetable Manure,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
22	Potato Phosphate,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
23	Dissolved Bone and Potash,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
24	Empire Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Amherst.
25	Potato Manure,	Quinnipiac Co., Boston, Mass.,	Plymouth.
26	Pioneer Fertilizer,	Cleveland Dryer Co., Boston, Mass.,	Plymouth.
27	Special Potato Brand,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	New Bedford.
29	Practical Ammoniated Superphosphate,	Crocker Fertitizer and Chemical Co., Buffalo, N. Y.,	New Bedford.
30	Cumberland Superphosphate,	Cumberland Bone Phosphate Co., Boston, Mass.,	Dartmouth.
31	Fish, Bone and Potash,	Read FertilizerCo., New York, N. Y.,	Amesbury.
32	Americus Brand Potato and Tobacco Manure,	Williams & Clarke Fertilizer Co., Boston, Mass.,	Greenfield.
69	Potato Manure,	Quinnipiac Co., Boston, Mass.,	Easthampton
194	Animal Fertilizer,	Lowell Fertilizer Co., Lowell, Mass.,	Lowell.
213	Potato Phosphate,	Lowell Fertilizer Co., Lowell, Mass.,	Lowell.
247	Complete Potato and Vegetable Manure,	Lowell Fertilizer Co., Lowell, Mass.,	Fall River.
276	Cumberland Superphosphate,	Cumberland Bone Phosphate Co., Boston, Mass.,	Housatonic.
286	Dissolved Bone and Potash,	Lowell Ferlilizer Co., Lowell, Mass.,	Fall River.
287	Potato Phosphate,	Lowell Fertilizer Co., Lowell, Mass.,	Springfield.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
2	Farmer's Choice Bone Phosphate,	12.83	2.18	1.65-2.47	4.66	4.37	3.12	12.15	11.5-14.	9.03	9.5-11.	4.37	4-6
3	Potato and Tomato Manure,	10.98	2.10	1.65-2.47	9.54	.80	1.20	11.54	10.5-13.5	10.34	9-11	8.16	6-8
4	Tobacco Fertilizer,	10.20	1.43	2.06-3.30	9.67	1.18	1.28	12.13	11-14	10.85	9-11	7.99	7-8
5	Martin's Bone Mixture,	7.25	1.21	.82-1.65	9.46	4.48	6.40	20.34	19-22	13.94	—	—	—
6	Normal Bone Phosphate,	13.97	1.14	.82-1.65	5.50	1.54	1.66	8.70	8-11	7.04	7-9	4.04	4-6
7	S. C. Phosphate,	8.72	—	—	14.46	1.28	.90	16.64	15-19	15.74	13-16	—	—
8	S. C. Phosphate with Potash, 2 %	12.27	—	—	9.34	4.10	1.40	14.84	—	13.44	9-12	2.15	2
17	Champion Fertilizer,	3.45	4.33	3.94	—	4.58	10.24	14.82	14.70	4.58	8.38	7.58	5.30
20-194	Animal Fertilizer,	6.12	3.54	2.46-3.25	3.70	4.98	2.44	11.12	10-12	8.68	9-12	4.05	4-5
21-247	Complete Potato and Vegetable Manure,	7.07	2.43	2-3	4.98	4.10	2.30	11.38	9-10	9.08	8-10	3.69	3.5-4.5
22-213-287	Potato Phosphate,	9.51	2.64	2.47-3.30	5.17	3.01	1.54	9.72	9-10	8.18	8-10	6.08	6-7
23-286	Dissolved Bone and Potash,	10.47	1.73	1.65-2.50	5.58	4.35	2.97	12.90	10-11	9.93	9-11	1.94	2-3
24	Empire Fertilizer,	5.67	1.84	1.22-2.05	2.68	3.98	2.04	8.70	—	6.66	7-9	2.01	2-3*
25-69	Potato Manure,	9.47	2.56	2.47-3.30	4.60	1.61	2.37	8.58	7-11	6.21	6-9	5.54	5-6
26	Pioneer Fertilizer,	14.55	1.18	.82-1.64	4.78	2.85	1.89	9.52	9-12	7.63	7-9	1.08	1-3
27	Special Potato Brand,	13.92	3.62	3.70-4.50	6.96	1.74	.51	9.21	9-12	8.70	8-10	6.12	5.4-6.4
29	Practical Ammoniated Superphosphate,	20.95	1.29	.82-1.64	5.07	3.07	3.22	11.36	9-12	8.14	8-10	1.72	1.08-2.00
30-276	Cumberland Superphosphate,	15.25	2.37	2.06-2.89	5.17	3.84	2.81	11.82	10-13	9.01	8-10	2.22	2-3
31	Fish, Bone and Potash,	11.10	2.66	2.5-3	1.87	2.53	1.84	6.24	5-6	4.40	4-5	4.83	4-5
32	Americus Brand Potato & Tobacco Manure,	13.02	3.04	2.06-2.89	3.96	4.60	3.08	11.64	9-13	8.56	8-11	3.80	3-4

*Sulphate of potash the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
37	English Lawn Fertilizer,	Bradley Fertilizer Co., Boston, Mass.,	Amherst.
39	Potato, Onion and Tobacco Manure,	Wilcox Fertilizer Works, Mystic, Conn.,	Amherst.
40	High Grade Fish and Potash,	Wilcox Fertilizer Works, Mystic, Conn.,	Amherst.
41	Fish and Potash,	Wilcox Fertilizer Works, Mystic, Conn.,	Amherst.
42	Potato Manure,	Packer's Union Fertilizer Co., New York, N. Y.,	Amherst.
43	Animal Corn Fertilizer.	Packer's Union Fertilizer Co., New York, N. Y.,	Amherst.
44	Universal Fertilizer,	Packer's Union Fertilizer Co., New York, N. Y.,	Amherst.
46	Potato Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Northampton
47	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Northampton
49	Dry Ground Fish,	Williams & Clark Fertilizer Co., Boston, Mass.,	Northampton
55	Tankage,	Bowker Fertilizer Co., Boston, Mass.,	Northampton
58	Market Garden Fertilizer,	Bowker Fertilizer Co., Boston, Mass.,	Northampton
70	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Easthampton
73	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Easthampton
75	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.	Easthampton
108	Dry Ground Fish,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
126	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
175	Potato Manure,	Bradley Fertilizer Co., Boston, Mass.,	Haverhill.
188	Potato Phosphate,	Williams & Clark Fertilizer Co. Boston, Mass.,	Greenfield.
271	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt,,	Tyringham.
277	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Tyringham.
343	Ammoniated Bone Superphosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Fitchburg.
349	Potato Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Fitchburg.
366	Animal Corn Fertilizer,	Packer's Union Fertilizer Co., New York, N. Y.,	Westfield.
377	Potato Manure,	Packer's Union Fertilizer Co., New York, N. Y.,	Westfield.
381	Universal Fertilizer,	Packer's Union Fertilizer Co., New York, N. Y.	Westfield.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
37	English Lawn Fertilizer,	7.76	4.97	4.95-5.78	.90	4.09	2.33	7.32	6-8	4.99	5-7	2.66	2.5-3.5
39	Potato, Onion and Tobacco Manure,	14.22	2.58	3.30-4.30	2.44	5.62	2.18	10.24	8-10	8.06	7-9	6.74	6-7
40	High Grade Fish and Potash,	18.55	3.39	3.25-4.25	3.20	2.56	1.28	7.04	6-8	5.76	5-7	4.83	4-5
41	Fish and Potash.	21.60	2.86	2.5-3.5	.52	4.60	2.94	8.06	6-8	5.12	5-7	3.92	3-4
42-377	Potato Manure,	12.60	2.13	2.06-2.88	6.40	2.31	1.79	10.50	9-15	8.71	8-12	6.00	6.-8.
43-366	Animal Corn Fertilizer,	12.46	2.53	2.47-3.29	5.84	3.12	1.66	10.62	9-15	8.96	8-12	2.26	2-4
44-381	Universal Fertilizer,	14.45	1.24	.82.1.64	6.02	2.68	1.02	9.72	9-15	8.70	8-12	4.98	5-8
46-188-349	Potato Phosphate,	10.92	3.70	2.47.2.30	4.60	1.20	2.44	8.26	7-11	5.80	6-9	5.10	5-6
47-126-343	Ammoniated Bone Superphosphate,	12.90	2.50	2.47-3.20	7.34	2.23	2.10	11.67	10-13	9.57	9-11	2.32	2-3
49-108	Dry Ground Fish,	10.35	10.12	7.41-9.06	.26	4.54	2.68	7.48	7-9	4.80	—	—	—
55	Tankage,	5.10	2.62	2.47-3.30	—	2.44	11.76	14.20	13-15	2.44	—	—	—
58	Market Garden Fertilizer,	12.64	2.42	2.25-3.25	6.24	.94	3.51	10.69	8-12	7.18	6-8	9.56	10-12
70-175	Potato Manure,	9.67	2.61	2.50-3.25	4.22	2.79	1.56	8.57	8-11	7.01	6-8	5.54	5-6
73-277	Potato Manure,	14.45	2.33	2.05-2.88	5.96	2.21	1.71	9.98	9-14	8.17	8-12	3.48	3.25-4.
75-271	Corn Fertilizer,	13.17	2.60	1.64-2.47	5.76	2.70	2.04	10.50	9-15	8.46	8-12	2.30	2-3

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897,, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
83	Superphosphate,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
84	Complete Manure for Top-dressing Grass,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
91	Eagle Brand for Grass and Grain,	W. H. Abbott, Holyoke, Mass.,	Holyoke.
93	Pride of the Valley,	Kirley & Griffith Bros., S. Hadley Falls,	S. Hadley Falls
99	Fish and Potash,	Bradley Fertilizer Co., Boston, Mass.,	Holyoke.
100	Complete Manure for Corn and Grain,	Bradley Fertilizer Co., Boston, Mass.,	Holyoke.
105	Market Garden Fertilizer,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
106	Essex Potato Root and Vegetable Manure,	Russia Cement Co., Gloucester, Mass.,	Beverly.
114	Potato Manure,	Mapes Formula & Peruvian Guano Co., New York, N. Y.	Greenfield.
116	Seeding Down Manure,	Bradley Fertilizer Co., Boston, Mass.,	Haverhill.
117	Meat and Bone,	Thomas Hersom, New Bedford, Mass.,	Amherst.
119	Essex Corn, Grain and Grass Manure,	Russia Cement Co., Gloucester, Mass.,	Beverly.
122	Potato, Hop and Tobacco Phosphate,	M. E. Wheeler & Co., Rutland, Vt.,	Greenfield.
125	Corn Phosphate,	Williams & Clark Fertilizer Co,, Boston, Mass.,	Greenfield.
127	Complete Manure for General Use,	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Greenfield.
130	Bay State Ammoniated Bone Superphosphate,	E. Frank Coe Co., New York, N. Y.,	Haverhill.
132	Original Bay State Bone Superphosphate,	H. J. Tucker & Co., Boston, Mass.,	Haverhill.
134	Fish and Potash,	Williams & Clark Fertilizer Co., Boston, Mass.,	Greenfield.
171	Essex Potato, Root and Vegetable Manure,	Russia Cement Co., Gloucester, Mass.,	Sunderland.
182	Essex Corn, Grain and Grass Manure,	Russia Cement Co., Gloucester, Mass.,	Athol.
184	Seeding Down Manure,	Bradley Fertilizer Co., Boston, Mass.,	Athol.
185	Essex Potato Root and Vegetable Manure,	Russia Cement Co., Gloucester, Mass.,	Athol.
195	Original Bay State Bone Superphosphate,	H. J. Tucker & C., Boston, Mass.,	Leominster.
329	Essex Potato, Root and Vegetable Manure,	Russia Cement Co., Gloucester, Mass.,	Palmer.
331	Complete Manure for General Use,	Mapes Formula & Peruvian Guano Co., New York, N.Y.	Worcester.
351	Corn Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,.	Fitchburg.
352	Eagle Brand for Grass and Grain,	W. H. Abbott, Holyoke, Mass.,	Amherst.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
83	Superphosphate,	9.82	2.66	2.06-2.47	3.32	4.74	7.04	15.10	10-12	8.06	8-10	3.34	2.5-3.
84	Complete Manure for Top Dressing,	5.77	4.34	4.12-4.94	1.48	4.16	6 26	11.90	7-9	5.64	5-6	8.76	7-9
91-352	Eagle Brand for Grain and Grass,	9.82	2.50	2.47-3.30	—	7.16	11.52	18,68	17-18	7.16	—	10.00	10-11*
93	Pride of the Valley,	15.90	1.95	1.5-2.5	.52	3.12	3.78	7.32	7-9	3.64	—	8.47	8-10
99	Fish and Potash,	16.35	2.07	2.06-2.88	1.80	2.94	3.32	8.06	7.5-10.5	4.74	6-8	2.46	2-3
100	Complete Corn and Grain Manure,	10.93	3.36	3.30-4.12	5.50	8.67	1.28	15.45	13-16	14.17	12-14	3.36	3 4
105	Market Garden Fertilizer,	11.12	3.47	2.5-3.	6.52	1.66	2.56	10.74	9-11	8.18	7-9	6.64	6-8
106-171-185-329	Essex Potato, Root and Vegetable,	7.03	4.75	3.71-4.53	4.02	3 68	2.23	10.93	9-11	7.70	7-8	9.16	8.5-10.*
114	Potato Manure,	7.65	3 81	3.71-4.12	4.60	2.90	2.30	9.80	8-10	7.50	8	7.66	6-8*
116-184	Seeding Down Manure,	12.32	2.72	2.5-3.25	6.26	5.55	1.16	12.97	12-16	11.81	7-9	2.20	2-3
117	Meat and Bone,	12.50	5.05	4 5-5.5	—	5.12	12.66	17.78	17-18	5.12	5-6	—	—
119-182	Essex Corn, Grain and Grass	8.67	4.04	3.7-4.5	3.61	5.49	2.70	11.80	9.5-11	9.10	7-8	9.94	9.5-11
122	Potato, Hop and Tobacco Phosphate,	13.04	2 20	2-3	7.54	4.63	.52	12.69	11-14	12.17	10-12	3.50	3.25-4.30
125-351	Corn Phosphate,	12.09	2.36	2.06-2.89	7.65	1.71	2.15	11.51	10-14	9.36	9-12	1.76	1.5-2.5
127-331	Complete Manure for General Use,	15.55	3.61	3.30-4.12	5.76	2.75	2.49	11.00	10-12	8.51	8-10	5.26	4-5
130	Bay State Ammoniated Bone Superphos'te,	12.33	2.03	2.-2.8	7.11	1.34	2.71	11.16	11-13	8.45	9-12	2.12	1.85-2.
132-195	Original Bay State Bone Superphosphate,	18.97	2.09	2.06-2.47	7.01	1.97	2.53	11.51	11 13	8.98	9-12	2.14	2-3
134	Fish and Potash,	16.05	2.41	2.-2.85	1.40	3.58	3.46	8.44	6-9	4.98	4.-6	4.05	4-6

*Sulphate of potash the source of potash.

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
136	Complete Fertilizer for Tobacco,	National Fertilizer Co.. Bridgeport, Conn.,	Sunderland.
138	Fish and Potash,	W. J. Brightman & Co., Tiverton, R. I.,	Taunton.
140	Wood Ashes,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
141	Potato and Tobacco Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
144	Bay State Potato Manure,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
145	Dry Ground Fish,	National Fertilizer Co., Bridgeport, Conn.,	Sunderland.
148	Pulverized Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Hadley.
149	Fish and Potash,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
151	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	Plymouth.
152	Fish and Potash " D " Brand,	Joseph Church, Tiverton, R. I.,	Springfield.
153	Bay State Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
154	Harvest Home Phosphate,	H. J. Baker & Bro., New York, N.Y.,	Springfield.
156	Potato Special Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Springfield.
157	Four Fold Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Springfield.
158	Standard Un XLD Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
162	Complete Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
163	King Philip Alkaline Guano,	Clark's Cove Fertilizer Co., Boston, Mass.,	Springfield.
228	Fish and Potash " D " Brand,	Joseph Church, Tiverton, R. I.,	New Bedford
261	Pulverized Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
265	Wood Ashes,	Bowker Fertilizer Co., Boston, Mass.,	Sunderland.
273	Market Garden Manure,	Quinnipiac Co., Bostor, Mass.,	Pittsfield.
284	Market Garden Manure,	Quinnipiac Co., Boston, Mass.,	Taunton.
289	King Philip Alkaline Guano,	Clark's Cove Fertilizer Co., Boston, Mass..	North Adams
315	Bay State Potato Manure,	Clark's Cove Fertilizer Co., Boston, Mass.	Westfield.
316	Complete Fertilizer for Tobacco,	National Fertilizer Co., Bridgeport, Conn.,	Hadley.
378	Bay State Fertilizer,	Clark's Cove Fertilizer Co., Boston, Mass.,	Spencer.
383	Complete Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	Worcester.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
136-316	Complete Fertilizer for Tobacco,	9.91	4.20	3.30-4.10	6.22	2.59	.38	9.19	9-10	8.81	8-11	7.90	10-12
138	Fish and Potash,	17.28	3.13	2.07-2.90	1.64	4.19	2.87	8.70	7.5-10.5	5 83	6-8	2.30	2-3
140-265	Wood Ashes,	11.12	—	—	—	—	—	.83	1-3	—	—	5.38	5-7
141	Potato and Tobacco Fertilizer,	10.17	2.56	2.06-2.80	3.97	4.93	3.07	11.97	9-13	8.90	7.5-11	3.64	3-4
144-315	Bay State Potato Manure,	11.05	2,47	2.47-3.30	3.25	5.24	2.60	8.49	7-11	8·49	6-9	5.02	5-6
145	Dry Ground Fish,	15.10	8.88	8.24-9.06	—	3.58	4.10	7.68	6-8	3.58	—	—	—
148-261	Pulverized Bone and Meat,	3.92	4 25	4.94-5.77	—	4.22	12.54	16.76	18-20	4.22	—	—	—
149	Fish and Potash,	17.09	2.17	2.06-2.89	2.04	3.95	2.94	8.93	7-10	5.99	6-8	2.13	2-3
151-273-284	Market Garden Manure,	10.77	4.12	3.30-4.12	4.91	3.51	1.84	10.26	9-13	8.42	8-11	7.06	7-8
152-228	Fish and Potash "D" Brand,	17.87	2.28	2.07-2.90	2.32	3.23	3.08	8.63	7.50-10.5	5.55	6-8	2.34	2-3
153-378	Bay State Fertilizer,	11.17	2.76	2.47-3.30	5.24	4.86	2.44	12.54	10-14	10.10	9-12	2.07	2-3
154	Harvest Home Phosphate,	12.50	1.45	1.30-1.65	3.84	4.45	2.38	10.67	9-10	8.29	8-9	2.32	2-3
156	Potato Special Fertilizer,	7.93	2.11	2.00-2.25	7.98	3.25	3.30	14.53	13-15	11.23	9-10	5.18	5-6
157	Four Fold Fertilizer,	10.07	1.32	1.-1.25	4.60	4.12	3.04	11.76	11-14	8.72	8-10	1.62	1-2
158	Standard Un X L D Fertilizer,	14.61	2.28	1.85-2.68	6.91	1.51	1.66	10.08	9-11	8.42	8-10	2.60	2.25-3.25
162-383	Complete Corn Manure,	10.32	4.07	4.11-5.00	5.37	1,69	1.00	8.06	7.25-9.00	7.06	6-8	6,96	7-8
163-289	King Philip Alkaline Guano,	10.91	1.19	.91-1.65	4.10	4.74	1.80	10.64	9-12	8.84	8-10	2.06	2-3

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
166	Sheep Fertilizer,	J. J. Peters & Co., Long Island, N. Y.,	Boston.
167	Nobsque Guano,	Pacific Guano Co., Boston Mass.,	Plymouth.
169	High Grade F. F. Truck Fertilizer,	Read Fertilizer Co., New York, N. Y.,	Amesbury.
172	Soluble Pacific Guano,	Pacific Guano Co., Boston, Mass.,	Sunderland.
174	Garden Special,	Great Eastern Fertilizer Co., Rutland, Vt.,	Leverett.
176	Essex Cauliflower and Cabbage Manure,	Russia Cement Co., Gloucester, Mass.,	Beverly.
179	Complete Manure with 10 per cent Potash,	Bradley Fertilizer Co., Boston, Mass.,	Beverly.
181	Essex Special Cauliflower and Cabbage Manure.	Russia Cement Co., Gloucester, Mass.,	Athol.
183	Essex Odorless Lawn Dressing,	Russia Cement Co., Gloucester' Mass.,	Athol.
186	Fine Ground Tankage,	Williams & Clark Fertilizer Co., Boston Mass ,	Athol.
187	Fish and Potash,	Cumberland Bone Phosphate Co., Boston, Mass.,	Dartmouth.
191	Potato Phosphate,	Cleveland Dryer Co., Boston, Mass.,	W. Andover.
196	Animal Fertilizer,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Lowell.
197	Royal Bone Phosphate,	Williams & Clark Fertilizer Co., Boston, Mass.,	Chelmsford.
198	Imperial Bone Superphosphate,	H. F. Tucker & Co., Boston, Mass.,	Leominster.
201	Special Potato Fertilizer,	H. F. Tucker & Co., Boston, Mass.,	Leominster.
203	Butman Brand Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Andover.
204	Northern Corn Special,	Great Eastern Fertilizer Co., Rutland, Vt.,	Chelmsford.
205	Lowell Lawn Dressing,	Lowell Fertilizer Co., Lowell, Mass.,	Lowell.
206	High Grade Complete Manure,	Cleveland Dryer Co., Boston, Mass.,	W. Andover.
225	Sheep Fertilizer,	J. J. Peters & Co., Long Island, N. Y.,	Boston.
266	Soluble Pacific Guano,	Pacific Guano Co., Boston, Mass.,	Sunderland.
269	Nobsque Guano,	Pacific Guano Co., Boston, Mass.,	Lanesboro'gh
292	Lowell Lawn Dressing,	Lowell Fertilizer Co., Lowell, Mass.,	Springfield.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
166-225	Sheep Fertilizer,	17.12	1.60	2.36	—	—	—	1.63	1.62	—	—	2.31	2.46
167-269	Nobsque Guano,	14.95	1.17	1.15-1.65	5.62	2.82	1.92	10.36	9-14	8.44	8-12	2.48	2-3
169	High Grade F. F. Truck Fertilizer,	10.77	3.84	3.25-3.75	5.50	1.78	2.44	9.72	9-12	7.28	7-8	7.24	7-8
172-266	Soluble Pacific Guano,	10.25	2.48	2.47-3.30	4.34	2.24	2.24	8.82	7-11	6.58	6-9	11.12	10-11*
174	Garden Special,	13.80	3.57	3.30-4.00	5.22	1.43	1.54	8.19	—	6.65	6-8	6.84	8-10
176	Essex Cauliflower and Cabbage Manure,	6.81	4.58	4-5	4.22	2.82	3.96	11.00	9-11	7.04	7-8	7.67	7.5-8.5
179	Complete Manure with 10 per cent Potash,	8.11	3.40	3.30-4.13	2.44	4.34	2.56	9.34	7-10	6.78	6-10	10.00	10-12
181	Essex Special Cauliflower and Cabbage,	6.62	4.72	4.12-4 94	4 34	3.72	3.96	12.02	10.5-12.5	8.06	7.5-8.5	7.24	7.5-8.5*
183	Essex Odorless Lawn Dressing,	2 97	2.26	3.71-4.53	.56	3.54	5.76	9.86	7-8	4.10	5.5-6.5	7.56	7-8
186	Fine Ground Tankage,	5.65	7.60	7.41-8.24	—	3.20	5.50	8.70	6.87-9.16	3.20	—	—	—
187	Fish and Potash,	16.65	2.12	2.07-2.90	2.04	3.71	3.08	8.83	7.5-10.5	5.75	6-8	2.09	2-3
191	Potato Phosphate,	11.08	2.14	2.05-2 85	5.62	4.54	2.04	12.20	10-13	10.16	8-10	3.02	3-4
196	Animal Fertilizer,	9.98	3.40	3.30-4.94	3.70	4.20	5.12	13.02	10-12	7.90	6-8	4.46	4-6
197	Royal Bone Phosphate,	14.52	1.65	1.03·1.64	6.02	1.90	2.18	10.10	8-11	7.92	7-9	2.22	2-3
198	Imperial Bone Superphosphate,	13.08	2.35	1.-1.50	5.81	4.43	2.02	12.26	11-15	10.24	9-12	1.82	1.85
201	Special Potato Fertilizer,	8.00	4.42	2.06-2.88	4.74	2.04	2.56	9.34	9-12	6.78	8-11	6.08	6-7
203	Butman Brand Fertilizer,	6.67	2.54	2.47-3.30	1.40	6.39	3.21	11.00	8-11	7.79	7-9	2.94	2.5-4.00
204	Northern Corn Special,	13.01	3.28	2.88-3.88	6,52	2.33	1.92	10.77	9-13	8.85	8-10	2.34	2-3
205-292	Lowell Lawn Dressing,	7.15	2.32	4.12-4.94	3.32	3.34	4.34	11.00	9-12	6.66	8-10	5.31	5 6
206	High Grade Complete Manure,	11.34	3.50	3.30 4.12	6.93	1.39	1.51	9.83	9-13	8.32	8-11	7.34	7-8

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Nane of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
208	High Grade Ammoniated Bone Superphosphate,	E. Frank Coe Co., New York, N. Y.,	Chelmsford.
212	X X V Ammoniated Bone Superphosphate,	E. Frank Coe Co., New York, N. Y.,	Chelmsford.
214	Gold Brand Excelsior Guano,	E. Frank Coe Co., New York, N. Y.,	Sunderland.
216	General American for all Crops,	American Fertilizer Co., Boston, Mass.,	Dartmouth.
217	Potato Fertilizer,	Cumberland Bone Phosphate Co., Boston, Mass.,	North Adams
218	Plymouth Rock Brand,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Beverly.
221	Clover Brand Bone and Wood Ash,	Bowker Fertilizer Co., Boston, Mass.,	Taunton.
223	Quinnipiac Grass Fertilizer,	Quinnipiac Co., Boston, Mass.,	Plymouth.
227	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	New Bedford
230	Ammoniated Bone Superphosphate,	Preston Fertilizer Co., Greenpoint, L. I.,	Pittsfield.
231	General Crop Phosphate,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Westport.
232	Sure Crop Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	North Adams
236	Wood Ashes,	E. McGarvey, London, Ontario, Canada,	Amherst.
238	High Grade Potato Fertilizer,	E. Frank Coe. Co., New York, N. Y.,	Lee.
240	Ammoniated Bone Superphosphate,	National Fertilizer Co., Bridgeport, Conn.,	Dighton.
243	Ammoniated Bone Phosphate,	Berkshire Mills, Bridgeport, Conn.,	Gt. Barrin't'n
244	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Co., Buffalo. N. Y..	Westport.
245	Corn Manure,	Quinnipiac Co., Boston, Mass.,	Taunton.
248	Electrical Dissolved Bone,	M. E. Wheeler & Co., Rutland, Vt.,	Tyringham.
252	Animal Fertilizer with Potash,	Bartlett & Holmes, Springfield, Mass.,	Springfield.
253	Blood, Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
280	Quinnipiac Grass Fertilizer,	Quinnipiac Co., Boston, Mass.,	Pittsfield.
341	Corn Manure,	Quinnipiac Co., Boston, Mass.,	Fitchburg.
354	High Grade Ammoniated Bone Superphosphate,	E. Frank Coe Co., New York. N. Y.,	Lee.
388	Potato Fertilizer,	Cumberland Bone Phosphate Co., Boston, Mass.,	Stow.

Laboratory Number.	NAME OF BRAND.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
208-354	H. G. Ammoniated Bone Superphosphate, ..	11.30	2.04	2.-2.80	6.78	4.10	1.28	12.16	11-15	10.88	9-12	2.10	1.85-2.00
212	X X V Ammoniated Bone Superphosphate, .	10.73	1.37	1-1.25	6.66	3.95	2.82	13.43	9-11	10.61	8-10	1.32	1-2
214	Gold Brand Excelsior Guano, ...	10.74	2.47	2-3	6.24	2.36	1.74	10.34	9-10	8.60	8-11	5.99	9-11
216	General American for all Crops, ...	9.06	1.97	1.65-2.47	—	5.50	8.19	13.69	9-10	5.50	6-7	2.14	2-3
217-388	Potato Fertilizer, ...	11.65	2.15	2.06-2.89	4.50	4.96	2.92	12.38	11-14	9.46	9-11	3.12	3-4
218	Plymouth Rock Brand, ...	8.67	2.79	2.47-3.29	2.94	5.26	2.68	10.88	9-13	8.20	8-11	4.17	4-5
221	Clover Brand Bone and Wood Ash, ...	11.95	1.75	1.75-2.25	—	6.96	4.22	11.18	9-11	6.96	7-9	2.56	2.25-3.25
223-280	Quinnipiac Grass Fertilizer, ...	8.68	4.23	3.91-4.73	2.46	2.27	1,13	5.86	6-9	4.73	5-7	2.33	2-3
227-244	New Rival Ammoniated Superphosphate, ..	12.39	1.32	1.23-2.00	7.11	3.59	1.33	12.03	8-9	10.70	3-5	1.92	1.60-3.00
230	Ammoniated Bone Superphosphate, ...	13 90	3.12	2.5-3.5	4.86	2.69	6.96	14.51	—	7.55	9-11	2.96	2-3
231	General Crop Phosphate, ...	8.80	1.01	.82-1.64	2 68	3 55	1.80	8.03	8-12	6.23	7-10	1.24	1.08-2.50
232	Sure Crop Phosphate, ...	5.96	1.11	.75-1.50	.15	8.08	6.81	15.04	10-12	8.23	8-10	1.12	1-2
236	Wood Ashes, ...	12.75	—	—	—	—	—	1.44	1-1.50	—	—	7.16	5-6
238	High Grade Potato Fertilizer, ...	8.08	2.50	2.4-2.85	6.90	1.74	1.80	10.44	9-11	8.64	8-11	6.15	6-7
240	Ammoniated Bone Superphosphate, ...	12.57	1.90	1.60-2.00	5.62	2.82	4 10	12.54	9-11	8.44	7-9	2.60	2-3
243	Ammoniated Bone Phosphate, ...	7.72	2.01	1.65-2.47	1.28	4.60	7.42	13.30	10-12	5.88	8-10	2.14	2-3
245-341	Corn Manure, ...	11.97	2.35	2.06-2.89	5.38	3.54	3.24	12.16	10-14	8.92	9-12	1.81	1.50-2.50
248	Electrical Dissolved Bone, ...	8.97	—	—	2.94	6.52	6 02	15.48	15-20	9.46	13-17	—	—
252	Animal Fertilizer with Potash, ...	5.77	3.88	2.47-3.30	2.56	6.17	4.91	13.64	15-17	8.73	5-7	4.06	7-8
253	Blood, Bone and Meat, ...	15.08	6.33	5.77-7.41	—	4.89	6.19	11.08	10-12	4.89	—	—	—

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
272	Coarse Linseed Meal,	Cleveland Linseed Oil Co., Cleveland, Ohio.,	Fitchburg.
278	Farm and Garden Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	North Adams
299	Grass and Oat Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Willia'stown.
301	Seeding Down Manure,	Quinnipiac Co., Boston, Mass.,	Willia'stown.
304	Potato Manure,	Great Eastern Fertilizer Co., Rutland, Vt.,	Greenfield.
305	Universal Grass Grower,	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Willia'stown.
307	Special Strawberry Fertilizer,	Parmenter & Polsey Fertilizer Co., Peabody, Mass.,	Dighton.
308	Ammoniated Bone Phosphate,	Bradley Fertilizer Co., Boston, Mass.,	Taunton.
309	Potato Phosphate,	Quinnipiac Co., Boston, Mass.,	Taunton.
317	Fruit Fertilizer,	The Rogers & Hubbard Co., Middletown, Conn.,	Westfield.
320	Vegetable and Vine Fertilizer,	Read Fertilizer Co., New York, N. Y.,	Willia'stown.
323	Potato Fertilizer,	American Fertilizer Co., Boston, Mass.,	Fitchburg.
325	Standard Fertilizer,	Standard Fertilizer Co., Boston, Mass.,	Palmer.
326	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Co., Buffalo N. Y.,	Westport.
327	Wood Ashes,	Monroe, Lalor & Co., Oswego, N. Y.,	Worcester.
332	Blood, Bone and Potash,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Concord.
333	Farm and Garden Phosphate,	Bowker Fertilizer Co., Boston, Mass.,	Palmer.
344	Fertilizer for Hoed Crops,	American Fertilizer Co., Boston, Mass.,	Fitchburg.
350	Potato and Root Crop Manure,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
356	Potato, Tobacco and Hop Fertilizer,	Niagara Fertilizer Co., Buffalo, N. Y.,	Milbury.
359	Coarse Linseed Meal,	Cleveland Linseed Oil Co., Cleveland, Ohio,	Amherst,
360	Niagara Triumph,	Niagara Fertilizer Co., Buffalo, N. Y.,	Milbury.
363	Animal Fertilizer with Potash,	C. A. Bartlett, Worcester, Mass,,	Worcester.
365	Tobacco Ash Constituents,	Mapes Formula & Peruvian Guano Co., New York, N. Y.	Westfield.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
272-359	Coarse Linseed Meal,	10.48	6.42	6.5-7	—	—	—	1.36	1.70-1.80	—	—	1.46	1.45-1.60
278-333	Farm and Garden Phosphate,	11.48	1.81	1.50-2.50	3.84	3.74	4.86	12.46	10-14	7.58	8-11	2.24	2-3
299	Grass and Oat Fertilizer,	14.72	—	—	4.86	5.50	1.66	12.02	—	10.36	11-13	2.18	2-4
301	Seeding Down Manure,	11.25	1.29	.82-1.65	4.22	4.08	2.44	10.74	10-13	8.30	9-11	2.09	2-3
304	Potato Manure,	10.82	2.12	2.-3.50	5.84	3.10	2.04	10.98	9-11	8.94	8-9	4.04	4-4.50
305	Universal Grass Grower,	10.10	.84	.82-1.64	2 94	3.97	.38	7.29	8-12	6.91	7-10	3.28	2.7-4.00
307	Special Strawberry Fertilizer,	4.77	3.08	2.47-3.29	5.76	4.60	1.54	11.90	10-12	10.36	9-10	6.35	6-7
308	Ammoniated Bone Phosphate,	11.99	1.98	2-3	3.07	3.98	4.61	11.66	10-13	7.05	8-10	1.58	1-2
309	Potato Phosphate,	10.02	2.30	2.05-2.83	5.24	3.70	3.08	12.02	9-14	8.94	8-12	3.26	3-4
317	Fruit Fertilizer,	5.56	2.95	2.5-3.	—	5.53	12.51	18.04	17.5-18.5	5.53	—	12.90	12.5-13.5
320	Vegetable and Vine Fertilizer,	11.80	1.80	1.65-2.47	4.98	1.54	1.28	7.80	7-9	6.52	6-8	10.05	8-10
323	Potato Fertilizer,	5.17	2.58	3.-3.5	—	5.58	4.96	10.54	—	5.58	6-7	8.94	9-10
325	Standard Fertilizer,	14.28	2.14	2.-3.6	6.14	4.45	1.33	11.92	10-15	10.59	8-12	2.22	2.3
326	Ammoniated Wheat and Corn Phosphate,	16.57	2.00	2-3	7.54	5.09	1.80	14.43	11-15	12.63	10-13	1.76	1.60-2.70
327	Wood Ashes,	14.15	—	—	—	—	—	1.56	—	—	—	5.18	
332	Blood, Bone and Potash,	10.08	4.67	4.5-5.5	4.20	2.40	1.28	7.88	9-11	6.60	7-9	8.58	7-8
344	Fertilizer for Hoed Crops,	9.95	2.65	3.30-3.71	—	9.16	11.13	20.29	—	9 16	11-12	4.18	4-4.50
350	Potato and Root Crop Manure,	6.45	2.82	2.88-4.12	3,58	4.42	5.38	13.38	10-12	8.00	7-9	7.42	7-9
356	Potato, Tobacco and Hop Fertilizer,	11.83	1.91	1.64-2.40	5.73	2.99	1.87	10.59	9-12	8.72	8-10	3.12	2.7-3.78
360	Niagara Triumph,	10.47	3.04	2.47-3.29	5.68	3.02	2.04	10.74	9-12	8.70	8-10	2.37	2.16-3.24
363	Animal Fertilizer with Potash,	4.22	5.00	2.47-3.30	1.92	4.86	3.32	10.10	15-17	6.78	5-7	7.42	7-8
365	Tobacco Ash Constituents,	10.40	.70	.50	—	1.80	4.60	6.40	5.70	1.80	—	16.10	15.00

II. ANALYSES OF COMMERCIAL FERTILIZERS COLLECTED DURING 1897, IN THE GENERAL MARKETS BY THE AGENT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Laboratory No.	Name of Brand.	Name of Manufacturer.	Sampled at
	Compound Fertilizers.		
368	Fertilizer for Gardens and Lawns,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
372	Animal Fertilizer,	J. G. Jefferds, Worcester, Mass.,	Worcester.
386	Wood Ashes,	Fyfe, Fay & Plummer, Clinton, Mass.,	Palmer.
390	Tankage,	Lowe Bros. & Co., Fitchburg, Mass.,	Fitchburg.
391	Pure Ground Bone and Meat,	A. P. Henderson, Hanover, Mass.,	Hanover.
394	Boo Boo Plant Food,	City Florist, Brockton, Mass.,	Brockton.
	Ground Bones.		
9	Steamed Bone,	I. P. Thomas & Son Co., Philadelphia Pa.,	Amherst.
10	Pure Ground Animal Bone,	I. P. Thomas & Son Co., Philadelphia, Pa.,	Amherst.
18	Fine Ground Bone,	D. Whithed, Lowell, Mass.,	Lowell.
54	Fresh Ground Bone,	Bowker Fertilizer Co., Boston, Mass.,	Northampton
107	Ground Bone,	National Fertilizer Co., Bridgeport, Conn.,	North Hadley
310	Ground Bone,	Thomas L. Stetson, Randolph, Mass.,	Randolph.
337	Fine Raw Knuckle Bone Flour,	The Rogers & Hubbard Co., Middletown, Conn.,	Springfield.
338	Fine Ground Bone,	L. B. Darling Fertilizer Co., Pawtucket, R. I.,	Concord
357	Fine Ground Bone,	J. G. Jefferds, Worcester, Mass.,	Worcester.
375	Steamed Bone,	McQuade Bros., West Auburn, Mass.,	Worcester.
393	Ground Bone,	E. H. Smith, Northboro, Mass.,	Northboro.

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in 100 lbs.		Phosphoric Acid in 100 lbs.							Potassium Oxide in 100 lbs.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.		
	Compound Fertilizers.														
368	Fertilizer for Garden and Lawns,	9.40	4.00	4-6	3.50	4.18	5.06	12.74	10-12	7.68	—	5.08	5-6		
372	Animal Fertilizer,	7.62	2.80	2.47-3.30	3.58	3.44	7.94	14.96	16-18	7.02	11-13	2.51	2.5-3.5		
386	Wood Ashes,	8.47	—	—	—	—	—	2.30	1-2	—	—	6.79	5-6		
390	Tankage,	5.80	4.31	4.00-4.50	—	6.14	15.48	21.62	20-21	6.14	—	—	—		
391	Pure Ground Bone and Meat,	7.06	4.72	4-5	—	—	—	15.22	15-16	—	—	—	—		
394	Boo Boo Plant Food,	.85	3.30	—	—	.78	11.76	12.54	—	.78	—	7.74	—		
												Mechanical Analysis.			
												Fine.	Fine Med.	Med.	Coarse Med.
	Ground Bones.														
9	Steamed Bone,	5.90	2.57	2.06-2.47	—	7.57	16.43	24.00	22-26	7.57	—	74.32	19.52	6.16	—
10	Pure Ground Animal Bone,	7.00	4.09	4-5	—	4.30	20.64	24.94	21-23	4.30	—	7.59	17.62	65.70	9.09
18	Fine Ground Bone,	2.05	1.17	1.29	—	3.14	28.28	31.42	32.54	3.14	—	68.58	27.49	3.93	—
54	Fresh Ground Bone,	4.91	2.45	2.25-3.25	—	10.50	14.20	24.70	18-22	10.50	5-7	61.10	22.96	13.43	2.51
107	Ground Bone,	8.15	3.90	2.88-3.71	—	5.00	17.78	22.78	20-24	5.00	—	18.10	27.67	54.23	—
310	Ground Bone,	8.37	4.04	4.00-4.50	—	6.38	15.36	21.74	21-22	6.38	—	12.08	27.85	36.66	23.41
337	Fine Raw Knuckle Bone Flour,	8.65	4.16	3.82-4.00	—	9.75	16.48	26.23	24.7-25.6	9.75	—	76.53	22.44	1.03	—
338	Fine Ground Bone,	.05	2.80	2.88-3.30	—	7.06	16.89	23.95	24-26	7.06	—	72.84	20.20	6.96	—
357	Fine Ground Bone,	7.40	2.59	2.47-3.30	—	8.70	19.96	28.66	27-30	8.70	—	83.20	14.80	2.00	—
375	Steamed Bone,	4.95	3.36	2.78	—	4.48	16.88	21.36	24-52	4.48	—	63.12	30.33	6.55	—
393	Ground Bone,	4.03	4.99	3-4	—	6.74	15.92	22.66	23-24	6.74	8-9	—	—	—	—

TRADE VALUES
OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1897. Cents per pounds.
Nitrogen in ammonia salts,	13.5
“ nitrates,	14.
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers,	14.
“ “ “ cotton-seed meal, linseed meal and in castor pomace,	12.
“ “ “ fine ground bone and tankage,	13.5
“ “ “ medium ground bone and tankage,	11.
“ “ “ coarse bone and tankage,	8.
Phosphoric acid soluble in water,	5.5
“ “ soluble in ammonium citrate,	5.
“ “ in fine bone and tankage,	5.
“ “ in medium bone and tankage,	4.
“ “ in coarse bone and tankage,	2.5
“ “ in fine ground fish, cotton-seed meal, linseed meal, castor-pomace and wood ashes,	5.
“ “ insoluble (in am. cit.) in mixed fertilizers,	2.
Potash as Sulphate, free from Chlorides,	5.
“ “ Muriate,	4.5

The market value of low priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the current market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical conditions for a speedy action, exert as a rule, a decided influence on their selling price.

The market value of fertilizing ingredients like other merchandise is liable to changes during the season. The above stated values are based on the condition of the fertilizer market in centers of distribution in New England, during the six months preceding March 1897.

472, 484

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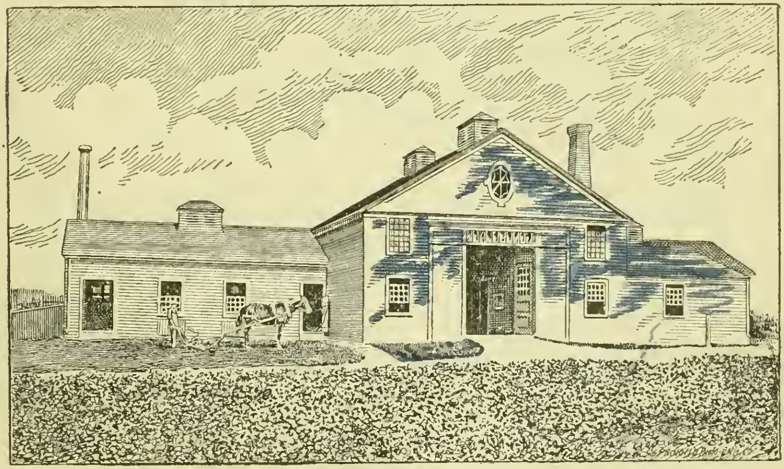
HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS AGRICULTURAL COLLEGE.

BULLETIN NO. 50.

THE FEEDING VALUE OF SALT MARSH HAY.



FEEDING BARN.

JANUARY, 1898.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
PRESS OF CARPENTER & MOREHOUSE,
1898.

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are :—

Henry H. Goodell, LL. D.,	*Director.*
William P. Brooks, Ph. D.,	*Agriculturist.*
George E. Stone, Ph. D.,	*Botanist.*
Charles A. Goessmann, Ph. D., LL. D.,	*Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D.,	*Chemist* (Foods and Feeding).
Charles H. Fernald, Ph. D.,	*Entomologist.*
Samuel T. Maynard, B. Sc.,	*Horticulturist.*
J. E. Ostrander, C. E.,	*Meteorologist.*
Henry M. Thomson, B. Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B. Sc.,	*Assistant Botanist.*
Henri D. Haskins, B. Sc.,	*Assistant Chemist* (Fertilizers).
Charles I. Goessmann, B. Sc.,	*Assistant Chemist* (Fertilizers).
George D. Leavens, B. Sc.,	*Assistant Chemist* (Fertilizers).
Edward B. Holland, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Fred W. Mossman, B. Sc.,	*Ass't Chemist* (Foods and Feeding).
Benjamin K. Jones, B. Sc.,	*Assistant in Foods and Feeding.*
Robert A. Cooley, B. Sc.,	*Assistant Entomologist.*
G. A. Drew, B. Sc.,	*Assistant Horticulturist.*
H. D. Hemenway, B. Sc.,	*Assistant Horticulturist.*
H. H. Roper, B. Sc.,	*Assistant in Foods and Feeding.*
A. C. Monahan,	*Observer.*

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

Hatch Experiment Station, Amherst, Mass.

The Feeding Value of Salt Marsh Hay.

J. B. Lindsey and B. K. Jones.*

SUMMARY OF RESULTS.

November, 1896—June, 1897.

I. The salt marsh hays are locally known as black grass, fox grass, branch grass, blue grass, (variety of red top) cove hay, salt hay mixture, and flat sage. The botanical names and their local equivalents, together with a description of the hays, will be found within the bulletin.

II. The hays were analyzed, their digestibilities were determined by the aid of sheep, and their effects upon the quantity, as well as their influence upon the quality of both milk and butter were carefully noted.

III. In chemical composition they quite closely resembled an average quality of English hay. They contained about the same amount of protein, less fiber, and rather more extract or starchy matter, and ash. The excess of ash is due to the presence of salt. In fertilizing constituents, the same amount of nitrogen was found as in English hay, and two-thirds as much phosphoric acid and potash.

IV. Salt hay, cut when in blossom and well cured, contains rather less digestible matter than average English hay cut under similar conditions. A ton of English hay with 14 per cent water (average amount when barn dry) being represented by 100, a ton of the several salt hays with 18 per cent water (average amount) would be equal to black grass 90, fox grass 85, branch grass 84, variety of red top† 84, cove mixture 88, salt hay mixture 82, and flat sage 88. Hence these salt hays, ton for ton, have *from 10 to 18 per cent less feeding value* than average English hay.

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* The laboratory work in connection with these experiments was performed chiefly by E. B. Holland and F. W. Mossman.

† This hay contained 14 per cent water. It was over ripe hence its low value. If cut in blossom and well cured, it would probably be nearly as valuable as English hay.

V. When fed in combination with grain and corn ensilage, the salt hays representing from 30 to 40 per cent of the total amount of digestible matter in the daily ration, the salt hay rations produced from 2 to 5 per cent less milk and butter than did an equal amount of English hay similarly combined. The variety of red top was the only exception to this; it yielded 9 per cent less milk and butter.

VI. When fed directly after milking, no objectionable flavor could be detected in the milk or butter. It is possible that if these hays were cut very soon after being covered by the tide they would then produce a disagreeable flavor. The so-called flat sage seems to possess a more pronounced salt flavor than the other grasses. This was not tested for flavor effect.

VII. The salt hay rations produced milk with a trifle less percentage of fat than did the English hay rations. The difference is so slight as to be of no practical importance.

VIII. Because of the lower market price for salt hays as compared with English hay, daily rations containing 10 to 12 pounds of salt hay produced milk and butter from 10 to 20 per cent cheaper than rations containing an equal amount of English hay.

IX. When there is a good market for English hay, it is undoubtedly wise to sell it, and feed salt hay in combination with corn ensilage as a substitute. One bushel of corn ensilage, and 12 pounds of salt hay make a good daily coarse fodder ration. If corn ensilage is not at hand, equal amounts of salt and English or pea and oat hay can compose the roughage ration. Any of the following grain mixtures may be fed in connection with the coarse fodders, for complete daily rations:

I.

50 pounds cotton seed meal,
100 pounds gluten feed,
100 pounds corn meal.
Mix and feed 5 to 7 quarts daily.

II.

50 pounds cotton-seed meal,
100 pounds gluten feed,
100 pounds wheat bran.
Mix and feed 7 to 9 quarts daily.

III.

100 pounds gluten meal,
100 pounds wheat bran.
Mix and feed 8 to 9 quarts daily.

IV.

100 pounds corn meal,
75 pounds gluten or cotton-seed meal.
Mix and feed 5 to 6 quarts daily.

V.

6 to 7 quarts of gluten feed daily.

The economy of the above different grain rations will depend on the local cost of the different feed stuffs.

X. It must be remembered that the value of salt hay is decidedly influenced by the time of cutting, and by the condition of the weather during the time of cutting and for a few weeks immediately after. A good deal of the salt hay cut would fall considerably below the value given to it above, because of late cutting and bad weather.

XI. For detailed record of each animal in the several feeding trials, see under heading H. For dry and digestible matter required to produce milk and butter fat, total amounts of feeds consumed in each feeding trial, and market value of same, see under heading I.

SUBDIVISION OF EXPERIMENTS.

A. General information concerning salt marsh hays.
B. Names and condition of salt hays tested.
C. Composition of salt hays.
D. Digestibility of salt hays.
E. Milk production with salt hays.
F. Effect of salt hays on the flavor of milk and butter.
G. Effect of salt hay on the composition of milk.
H. Detailed data of milk experiments.
I. General data.

A. GENERAL INFORMATION CONCERNING SALT-MARSH HAYS.

Reasons for experiments: At the country meeting of the State Board of Agriculture, held at Newburyport in December, 1894, considerable discussion was indulged in relative to the feeding value of different varieties of salt marsh hay. It was quite evident from the various opinions expressed, and from the lack of any data obtained from actual feeding experiments, that carefully conducted feeding trials were necessary, in order to obtain definite knowledge on the subject. As a step in this direction, four samples of salt hay were obtained through the kindness of Messrs. F. W. Sargent and J. Q. Evans of Amesbury. These hays were locally known as black grass, branch grass, high grown salt hay and fox grass. The two latter were practically identical, excepting that the former grew on rather more elevated marshes.

The hays were analyzed, their digestibility determined by feeding them to mature sheep, and the results published in the report of the Hatch Experiment Station for 1896. The keen interest excited in these tests, and the desire expressed by many for still further investigation led to procuring six different varieties, amounting in all to ten tons, during the autumn of 1896. These were fed to the milch cows and sheep; this bulletin contains a description of these experiments, and of the results obtained.

Salt marsh areas. Salt marshes occur to a considerable extent along the entire coast of Massachusetts, from Salisbury to New Bedford. According to the census of Massachusetts for 1885, the entire area of salt marsh is about 23,000 acres, yielding some 21,000 odd tons of salt hay annually—a trifle less than one ton per acre—with a valuation of $193,000. Essex Co. has 11,105 acres, Barnstable Co. 4,003 acres, Norfolk Co. 1,289 acres, and Plymouth Co. 1,818 acres. Four of the most valuable tracts for the production of salt hay are those in the vicinity of Newbury, the marsh between Lynn and Boston the one at Marshfield, and the "great marshes" of Barnstable Co. Considerable areas of inferior salt grasses are not cut. Large quantities of salt hay are used for litter, and for packing, while large amounts of the best grades are fed to horses and neat cattle.

Character of salt grasses. Although a considerable variety of grasses, sedges, etc. may be found growing upon the salt marshes at different times during the summer season, but five grasses predominate, and are of economic importance.

I. *Juncus Gerárdi*=Black grass.

Although popularly classed with grasses, it is not a true grass, but a rush. The slender stems are scarcely flattened, rigid and leafy below. It grows from 6 inches to 2 feet high, and is usually noticed along the edge of the marshes, where they join the main land. Evans* states that at the present time nearly one-half of the marshes in the vicinity of Newbury are covered with this grass. It blossoms the latter part of June, or early in July, and is then at its best for feeding. See Plate I.

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* Report State Board of Agriculture, 1894, p. 50.

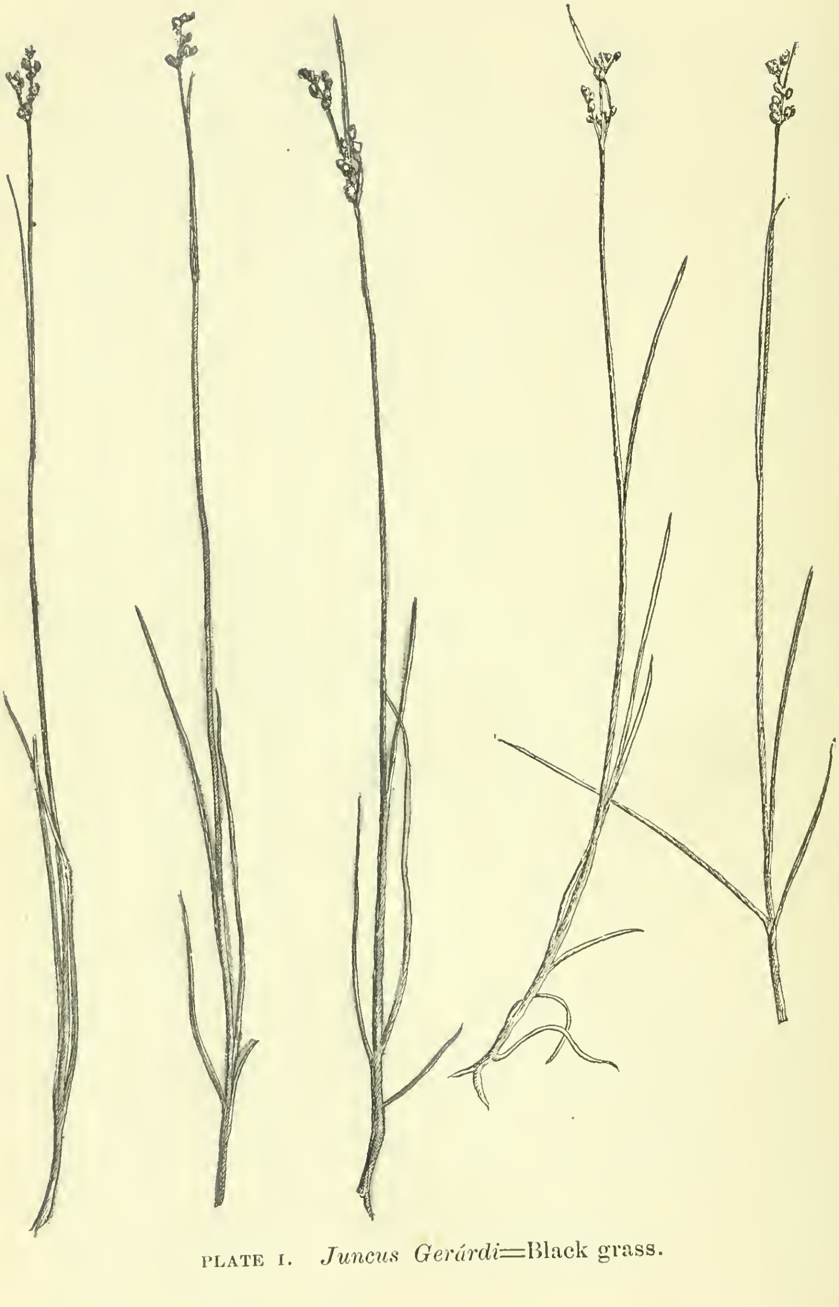

PLATE I. *Juncus Gerárdi*=Black grass.

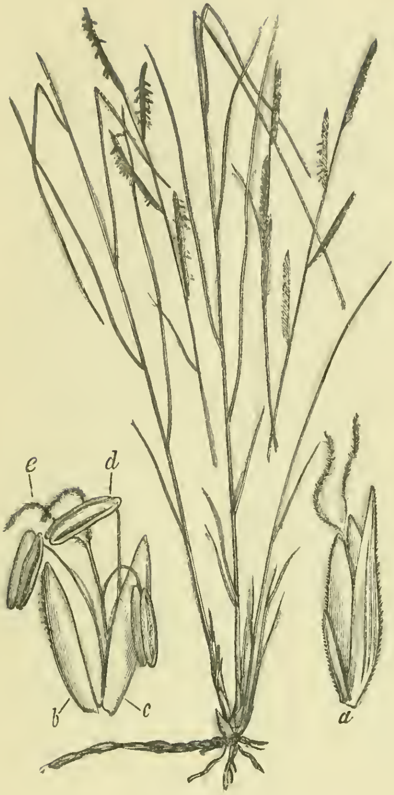

PLATE II.*

II. *Spartina patens*=Fox grass, rush salt grass, red salt, etc.

A slender, rather wiry grass 4 to 18 inches high, with two to four slender, erect or widely spreading spikes. It covers large areas of marsh, and is generally in full blossom early in August. It is easily recognized by its fine silky appearance, and by its red top or blossom. See Plate II.

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* Scribner, Bulletin 7, Division of Agrostology, U. S. Department of Agriculture.

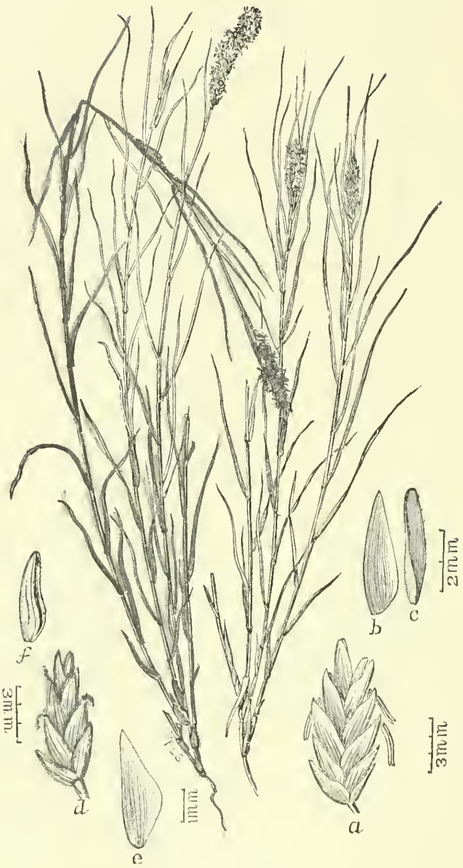

PLATE III.*

III. *Distichlis spicata*=Branch grass, alkali grass, spike grass, white salt, fine sage, etc. An upright, wiry grass, 6 to 18 inches high, with strong, widely creeping rootstocks, rigid leaves, and densely flowered panicles (Scribner). This grass is rather coarser than the fox grass and its leaves branch out more, hence its common name. Its compact head is nearly white, and it is generally in full blossom about the middle of August. When in blossom, it quite often covers up the fox grass. See Plate III.

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* Scribner, Bulletin 7, Division of Agrostology, U. S. Department of Agriculture.

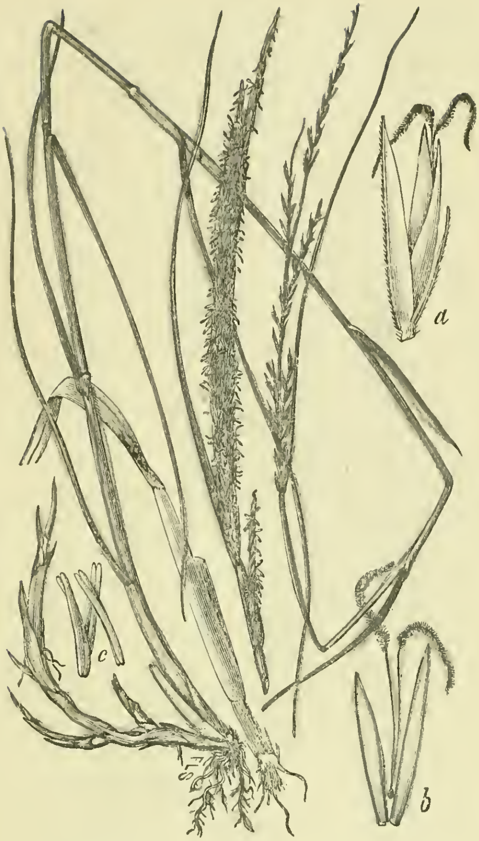

PLATE IV.†

IV. **Spartina stricta maritima*=creek sedge, or thatch. An erect and often stout salt marsh grass, from 2 to 6 feet tall, with long flat leaves, and few to many erect oppressed spikes (Scribner).

It is one of the two common grasses growing along the edge of the ditches and creeks where there is a daily flow of the tide. It has a long spike like head, and wide spreading, dark green leaves. It is used principally for bedding and mulching. See Plate IV.

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* The grass called *spartina stricta var. glabra* in the 12th report of the State Experiment station, 1894, was incorrectly named. It should have been *distichlis spicata.*

† Scribner, Bulletin 7, Division of Agrostology, U. S. Department of Agriculture.

V. *Spartina stricta maritima var. ?*=flat sage, prick ear, etc.

This grass appears to be a dwarf variety of the one just previously described. It covers quite large areas away from the ditches, rarely appears to blossom, and is easily recognized by its light pale green color. It grows 6 to 8 inches high. A few plants in blossom are occasionally seen from 12 to 18 inches high. No Plate.

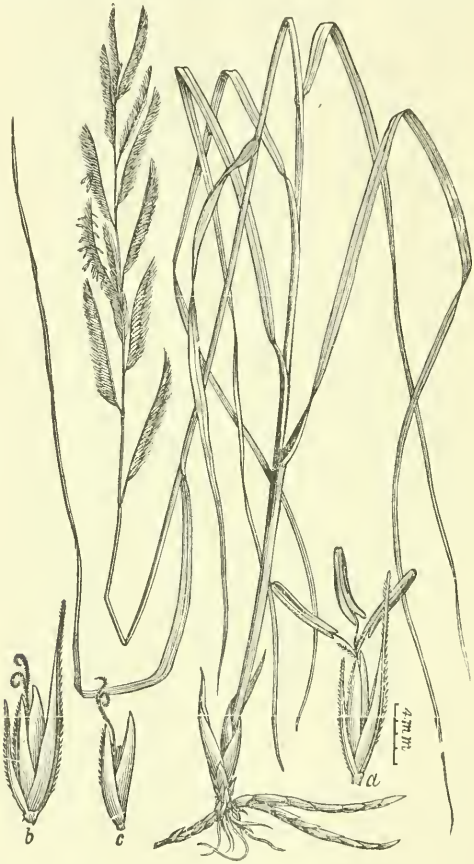

PLATE VI.*

VI. *Spartina cynosuroides*=thatch or cord grass.

A stout erect grass, two to six feet tall, with unbranched smooth culms from strong, scaly, creeping rootstocks, long tough leaf-blades, and five to twenty spikes forming a terminal panicle. (Scribner) It grows together with *stricta maritima* along the borders of the ditches. Its spike or top is fuller and branches out rather more than the latter. See Plate VI.

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* Scribner, Bulletin 7, Division of Agrostology, U. S. Department of Agriculture.

The salt marshes in the vicinity of Newbury contain large quantities of fox, black and branch grasses, together with the coarse thatch along the creeks. The predominating grass on the marshes between Lynn and Boston is the branch grass. This presented an excellent growth, when in full blossom the middle of August.

About Marshfield (Marshfield Hills) the so-called prick ear or flat sage occupies large areas, with some fox grass, and edges of black grass. On the "great marshes" at Barnstable, large areas of fox grass were seen, with considerable quantities of flat sage in wet places out towards the shore. Comparatively small areas of branch grass were noticed. The usual edge of black grass was seen.

Harvesting salt hay. The average yield of the marshes is from one-half to one ton per acre. The tides govern the time when the grass can be cut. They generally fill the creeks to within a foot of the surface of the marsh twice daily, and during very high tides the marsh is entirely submerged. Advantage has to be taken for cutting the hay of the week of low tides, which occur usually during the month of August. Considerable areas are now mown by machine. To prevent the horse from becoming mired, he is fitted with bog shoes made of hard wood, ten inches in diameter, clamped on to the hoof by a thumb nut in front. According to J. Q. Evans* three men and a horse will cut from eight to ten acres per day, the two men cutting with scythes about the edges and soft places, and the machine covering the rest. The grass after being cut is not turned, but allowed to dry just as it falls. After from two to three days cutting, the entire force begins to rake up each afternoon, using the horse-rake as far as possible. The hay is first brought into small cocks, and these cocks poled into large stacks holding about two tons each.

The stacks are raised about two feet from the surface of the marsh by being set on a number of stakes driven into the marsh. These stakes taken collectively are known as a staddle,and prevent the hay from getting wet or being carried away when high tides flood the marshes. The low tide period is generally of such short duration that as a rule it is not practicable to cut and remove the grass to high ground for drying and then run the risk of having it injured by bad weather. Should the weather during the harvest week prove bad, or should it be wet the first few weeks after cutting, the quality of the hay will be considerably impaired.

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* Report State Board of Agriculture, 1894, p. 50.

The cost of cutting and stacking the hay from considerable areas of marsh and of drawing the same a few miles to the barn usually amounts to from $4.00 to $5.00 per acre. The value of the salt grass standing is placed at $1.00 per acre.

B. NAMES AND CONDITION OF HAYS TESTED.

I. *Black grass.* This hay was in fair condition. It was rather damp and smelt mouldy. The animals ate their daily rations, but did not seem to relish it. The juice of this grass tasted very bitter. Whether this is true of black grass in general, or only at a certain stage of its growth, is not known.

II. *Fox grass, or high marsh hay.* This hay was in excellent condition.

III. *Branch grass, or low marsh hay.* This was in poor condition, being very damp, with a musty smell. Considerable difficulty was experienced in inducing the animals to eat the required quantity.

The above three varieties were secured with the help of Mr. J. Q. Evans of Amesbury, who devoted considerable time to the matter. Mr. Evans states that while the season was poor for securing the salt hays in the best condition, he was not aware that the branch grass was in as bad condition as represented.

Three other lots were sent by Mr. John Bursley, who secured them from the "great marshes" of Barnstable Co.

IV. *Red top variety.* This was a variety of ordinary red top, (*agrostis vulgaris*) and was not strictly speaking, a salt hay. It grew in what are termed cove meadows, which lie close by the salt marshes. A stream of fresh water usually flows through them, and they are overflowed with salt water at high runs of tide. Considerable sedge (*Eleocharis Engelmanni*) was scattered through this hay. In appearance it was the most desirable lot of hay received. It was however rather overripe, woody and lacking in flavor, so that the animals had no particular liking for it.

V. *Cove mixture.* A mixture of the red top above described and black grass, in good condition.

VI. *Salt hay mixture.* This was a mixture of branch grass, fox grass and flat sage, bright and in good condition.

VII. *Flat sage.* This was received later through the kindness of Mr. Lysander H. Richards of Marshfield Hills. It was analyzed and digestion tests were made.

The above local names will be used in referring to these grasses. Their botanical names, with various local equivalents, have already been given.

C. Composition of Salt Grasses.

NATURAL MOISTURE.

	English hay for comparison.	Black grass.	Fox grass.	Branch grass.	Red top.	Cove mixture.	Salt hay mixture.	Flat sage.
Water, per cent.,	13.00	16 00	17.00	21.00	13.00	18.00	16.00	17.00
Protein, “	6 56	7.32	7.27	6.22	6.78	7.23	5.44	6.49
Fiber, “	31 87	24.11	22.38	20.90	28 17	22 61	22.49	24.66
Extract matter, “	42.17	43.89	45.07	43.46	44.85	44.54	45.57	41.32
Fat, “	2.15	2.08	2 06	2 22	1.58	1.72	2.10	2.41
Ash, “	4.25	6.60	6.22	6.20	5.62	5.90	8.40	8.12
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

These grasses have a very similar composition. All of the salt grasses are noticeably lower in fiber than the English hay. In order to compare the composition of the dry matter (i. e. water free) the following figures are presented :

DRY MATTER BASIS.

	English hay for comparison.	Black grass.	Fox grass.	Branch grass.	Red top.	Cove mixture.	Salt hay mixture.	Flat sage.
Protein, per cent..	7.55	8 71	8.76	7.87	7.80	8.82	6.48	7.82
Fiber, “	36.68	28.71	26.96	26.46	32 32	27.57	26.77	29.71
Extract matter, “	48.40	52.23	54.31	55 00	51.54	54.32	54.26	49.77
Fat, “	2.48	2.48	2.46	2 82	1.82	2.10	2.51	2.91
Ash, “	4.89	7.87	7.51	7.85	6.46	7.19	9.98	9.79
	100.00	100.00	100.00	100.00	100 00	100.00	100.00	100.00

Here again is noticed the very close resemblance of the several salt hay varieties. The “salt mixture” contains rather more ashy matter. The English hay is rather above the normal in fiber, and must have been in advanced blossom when cut.

FERTILIZING CONSTITUENTS OF SALT HAY. (per cent with natural moisture.)

	English.	Black.	Fox.	Branch.	Red.	Cove.	Salt.	Sage.
Phosphoric acid,	.29	— .24	.18	.18	—	—	—	.31
Potash,	1.50	— 1.5	.92	.85	—	—	—	1.10
Nitrogen,	1 00	— 1.2	1.20	1.00	—	—	—	1.00
Salt percentages,	.72	3.71	2.46	3.18	—	—	—	3.91

D. DIGESTIBILITY.

Each of these seven samples was fed to three sheep, to determine the amounts of the several ingredients these animals were capable of digesting (i. e. turning into nourishment). Repeated experiments have proved that sheep, cows, oxen, etc. digest about equal quantities of different feed stuffs. Each sheep was fed 400 grammes of English hay, and 500 grammes salt hay daily. (1 pound=453.6 grammes) Knowing the digestibility of the English hay, the digestibility of the salt hay was calculated. Here follow the digestion percentages or coefficients of the several ingredients in each of the hays.

DIGESTION COEFFICIENTS.

	English hay for comparison.	Black grass.	Fox grass.	Branch grass.	Red top.	Cove mixture.	Salt hay mixture.	Flat sage.
Protein,	54	54	59	52	37	48	42	52
Fiber,	58	57	57	25	56	60	58	60
Extract matter,	56	49	53	46	46	53	52	55
Fat,	40	46	36	37	49	40	28	36

Using these determined percentages, we calculated the following amounts of each of the several ingredients digestible in one ton, on the basis of the natural moisture.

POUNDS DIGESTIBLE IN ONE TON.

	English hay	Black grass.	Fox grass.	Branch grass.	Red top.	Cove mixture.	Salt mixture.	Flat sage.
Protein,	71.	78.	86.	65.	50.	70.	46.	68.
Fiber,	376	274.	254.	104.	316.	272.	260.	296.
Extract matter,	488.	426.	478.	400.	412.	472.	474.	454.
Fat,	18.	18.	14.	16.	16.	14.	12.	17.
Total,	953.	796.	832.	585.	794.	828.	792.	835.
If the amount of digestible matter in 2000 lbs. English hay equals 100, the amount in one ton of other hays equals:	100	84	87	60	84	87	84	88

The salt hays, on the basis of the water they contained at the time of the experiment, showed, with one exception, from 13 to 16 per cent less digestible matter than was found in a ton of English hay. Branch grass will be considered further on.

During the year 1894 we received, as already stated, three typical samples of hay made from black, fox, and branch grasses, from which digestion experiments were made. In order to get all the light possible, it is now proposed to note the amounts of digestible matter in one ton of those samples, and also in one ton of our present samples, first on the basis of water free substance.

POUNDS WATER FREE SUBSTANCE DIGESTIBLE IN 2000 LBS.

	English hay for comparison.	Black grass.	Fox grass.	Branch grass.	Red top.	Cove mixture.	Salt mixture.	Flat sage.
1894 Samples,	1095.	1031.	967.	962.				
If English equals 100, others equal:	100	94	88	88				
Present samples,	1095.	948.	1002.	741.	913.	1010.	942.	1006.
If English equals 100, others equal:	100	87	91	68	83	92	86	92

The above results show that when considered ton for ton of water free matter, the black grass contained from 87 to 94 per cent as much digestible matter as found in the English hay, the fox grass from 88 to 91 per cent as much, a typical sample of branch grass 88 per cent as much, etc. We are therefore convinced that the present digestion experiment with branch grass fails to express its true value when in good condition.

In order if possible to draw closer conclusions, let us consider the digestibility of both the 1894 and the 1897 samples on the basis of 14 per cent water for the English hay, and 18 per cent water for the salt grasses, these being the water percentages the several hays would be most likely to contain under natural conditions.

POUNDS DIGESTIBLE IN ONE TON (NATURAL MOISTURE).

	English hay for comparison.	Black grass.	Fox grass.	Branch grass.	*Red top.	Cove mixture.	Soft mixture.	Flat sage.
1894 Samples,	942.	845.	793.	789.				
If English equals 100, others equal:	100	90	84	84				
1897 Samples,	942.	777.	822.		794.	828.	772.	825.
If English equals 100, others equal:	100	83	87		84	88	82	88.

*With 13 per cent water as found.

The results of the present digestion experiment with branch grass are omitted, for the reason that we believe them to be abnormal.

Taking all things into consideration, it is believed that the following figures express the relative values of a ton of well cured salt hay with 18 per cent water, when harvested at the proper time, as compared with a ton of average English hay receiving similar treatment, and having 14 per cent water.

	English hay.	Black grass.	Fox grass.	Branch grass.	Red top.*	Cove mixture.	Salt mixture.	Flat sage.
Relative values,	**100**	**90**	**85**	**84**	**84**	**88**	**82**	**88**

We have therefore concluded that a ton of black grass hay contains 10 per cent less nutritive matter, a ton of fox and branch grass hay about 15 per cent less, and the others from 12 to 18 per cent less than a ton of average English hay. It must not be forgotten that these are figures based on normal conditions, and that time of cutting and weather conditions during curing are likely to cause wide variations.

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* Red top variety contains but 13 to 14 per cent of moisture and hence shows a value about equal to branch grass. If it contained 18 per cent moisture, i. e. was as damp as other salt hays, it would show a relative value of 81.

E. Milk Production with Salt Hays.

General Plan.

Cows: Two lots of six cows each were employed in the experiments. In several cases one or two cows were not in condition, and hence the test was made with fewer animals. The animals were mostly grade Jerseys, fresh in milk in the early autumn. Full data concerning the animals will be found tabulated further on.

Time of experiments: The experiments were begun early in November, 1896, and completed the first week in June, 1897.

Care of animals: Six cows were kept in each wing of our experiment barn. They were allowed the run of a yard in pleasant weather. During the winter the wings were heated to a temperature of 50 to 60, plenty of fresh air being always admitted. The animals were carded daily, and every effort made to keep them as comfortable as possible, thus avoiding the undue influence of any external cause other than the effect of feed consumed. The milk of each animal was weighed on a Chatillon balance immediately after being drawn, and the weight recorded on especially prepared sheets.

Fodder rations: It was of course not possible to feed salt hay as an entire daily ration, neither was it thought advisable to make salt hay the only roughage. We therefore fed a constant basal ration of wheat bran, Chicago gluten meal, and corn ensilage. In addition to this, 10 to 12 pounds of salt or English hay were fed, so that the milk yield would increase or decrease because of the influence of either one or the other of these hays. For the reason that the salt hay contained from 6 to 8 per cent more water than did the English hay, we fed one pound more of the former, endeavoring to compare an equal quantity of dry material of the one, with a like amount of dry material of the other. Thus if an animal was fed 12 pounds of English hay in her daily ration, she would receive 13 pounds of salt hay.

Correction for milk shrinkage: In order to reduce the influence of the natural milk shrinkage to a minimum, three of the cows during the first half of the experiment were fed the English hay ration, at the same time the other three cows were receiving the salt hay ration; in the second half these conditions were reversed.

Sampling feeds and milk: A sample of milk was taken twice daily for four consecutive days, and this composite sample was held to represent the composition of the milk for the week.

A small sample of the two grains was taken daily, and preserved in glass stoppered bottles until the end of each half of the experiment. Very slight moisture variations were noted. A hay sample was taken weekly, tested for water present, and preserved. An occasional sample of ensilage was taken, and the several samples eventually mixed and analyzed.

Duration of each experiment: It was intended to have each experiment last 21 days, but owing to lack of time before the warm weather began, this 21 day period had to be reduced in some cases to 14 or 17 days. A preliminary period of 5 or 7 days, and in some cases longer, always preceded the period itself.

Weighing the animals: Each animal was weighed for three consecutive days at the beginning and end of each half of the experiment, the difference between these three average weights in each case representing the gain or loss in live weight during the half.

EXPERIMENT I.*

Black grass ration vs. English hay ration. Average results with six cows for 21 days:

FEEDS CONSUMED PER COW DAILY. (lbs.)

Ration.	Black grass.	English hay.	Corn ensilage.	Wheat bran.	Chicago gluten meal.
Black grass,	12.77	—	22.42	5	2.67
English hay,	—	11.83	22.50	5	2.67

AVERAGE DRY AND DIGESTIBLE MATTER PER COW DAILY. (lbs.)

Ration.	Total dry matter.	Protein.	Carbo-hydrates.	Fat.	Total digestible.	Nutritive ratio.
Black grass,	22.23	2.22	10.50	.55	13.27	5.3
English hay,	21.90	2.14	11.15	.54	13.83	5.8

TOTAL GAIN OR LOSS IN LIVE WEIGHT FROM SIX COWS. (lbs.)

Black grass ration,	—28.
English hay,	+18.

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* *The actual yield of milk and butter* of one experiment cannot be compared with the yields of milk and butter of another, for the reason that the experiments were made at different times during the year and with different cows. *Only the percentage increase or decrease* of each experiment is comparable.

AVERAGE MILK AND BUTTER YIELD PER COW DAILY. (lbs.)

Ration.	Milk.	Milk solids.	Milk fat.	Butter equivalent.
Black grass,	19.50	2.73	.95	1.11
English hay,	20.40	2.88	1.01	1.18
Percentage increase,				
English over black,	**+4.40**	**+5.24**	**+6.06**	

The black grass ration produced practically 5 per cent less milk and butter than did the English hay ration. Black grass however represented only about 40 per cent of the digestible matter of the ration, and mathematically, one might calculate that if 40 per cent black grass caused a 5 per cent shrinkage, 100 per cent black grass would cause 12.5 per cent shrinkage; i. e. a ton of dry material in the form of black grass would produce 12½ per cent less than an equal amount in the form of English hay. This figure (12½ per cent) tallies well with the results of the digestion tests. The comparison however cannot be strictly made from a practical standpoint, for the reason that it would not be advisable to feed cows on salt hay only. A slight correction, against the black grass ration, would also have to be made because of the loss of live weight during that period.

COST OF MILK AND BUTTER.

	Milk per quart.	Butter per pound.
Black grass,	1.84 cents	15 cents
English hay,	2.22 "	18 "
Percentage less cost of black grass ration,	**17.4**	**16.7**

The ration containing the black grass, because of its lower market value,* produced milk and butter from 18 to 20 per cent less than did the English hay ration.

EXPERIMENT II.

Fox grass ration (high marsh hay) vs. English hay ration. The animals ate the high marsh hay without any objection. Average results with five cows for 21 days:

FEEDS CONSUMED PER COW DAILY. (lbs.)

Ration.	Fox grass.	English hay.	Corn ensilage.	Wheat bran.	Chicago gluten meal.
Fox grass,	12.50	—	28	5	2.9
English hay,	—	11.60	28	5	2.9

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* The following valuations were put on the feed stuffs: English hay $18 per ton, salt hay $10 per ton, corn ensilage $3 50 per ton, wheat bran $15 per ton, Chicago gluten meal $20 per ton. It was believed that $10 and $18 represented fairly well the average market values of the two hays in towns along the coast.

AVERAGE DRY AND DIGESTIBLE MATTER PER COW DAILY. (lbs.)

Ration.	Total dry matter.	Protein.	Carbohydrates.	Fat.	Total digestible.	Nutitive ratio.
Fox grass,	23.40	2.39	11.47	.56	14.42	5.3
English hay,	23.10	2.26	11.90	.58	14.75	6.0

TOTAL GAIN OR LOSS IN LIVE WEIGHT FROM FIVE COWS.

Fox grass ration,	+25 pounds
English hay "	+29 "

AVERAGE MILK AND BUTTER YIELD PER COW DAILY. (lbs.)

Ration.	Milk.	Milk solids.	Milk fat.	Butter equivalent.
Fox grass,	24.80	3.22	1.00	1.16
English hay,	25.20	3.25	1.04	1.21
Percentage increase English over Fox grass ration,	**+1.6**	**+1.07**	**+4.10**	—

Fox grass composed about 40 per cent of the digestible matter of the ration and therefore calculated as explained under black grass, a ton of dry fox grass would prove to be but 4 per cent less valuable than a ton of dry English hay. The results with sheep show it to be 9 per cent less valuable on the same basis. The above results indicate that fox grass, if in good condition, did nearly as well in the ration fed in the present experiment, as did English hay.

COST OF MILK AND BUTTER.

Ration.	Milk per quart.	Butter per pound.
Fox grass,	1.54 cents	15.26 cents
English hay,	1.87 "	18.08 "
Increased percentage cost of English hay ration,	**18**	**15.5**

EXPERIMENT III.

Branch grass ration vs. English hay ration. Average results with six cows for 21 days. Attention has already been called to the fact that this hay was quite damp and mouldy. In some cases we were obliged to cut the hay, and mix the grain ration with it, before the animals would eat it.

FEEDS CONSUMED PER COW DAILY. (lbs.)

Ration.	Branch grass.	English hay.	Corn ensilage.	Wheat bran.	Chicago gluten meal.
Branch grass,	10.33	—	30.87	5	2.33
English hay,	—	9.33	30.67	5	2.33

AVERAGE DRY AND DIGESTIBLE MATTER PER COW DAILY. (lbs.)*

Ration.	Total dry matter.	Protein.	Carbo-hydrates.	Fat.	Total* digestible.	Nutritive ratio.
Branch grass,	21.26	2.05	9.64	.54	12.23	5.2
English hay,	21.36	2.05	11.11	.55	13.71	6.0

TOTAL GAIN OR LOSS IN LIVE WEIGHT FROM SIX COWS.

Branch grass ration,	—10
English hay "	+44

AVERAGE MILK AND BUTTER YIELD PER COW DAILY. (lbs.)

Ration.	Milk.	Milk solids.	Milk fat.	Butter equivalen
Branch grass,	24.70	3.19	.98	1.16
English hay,	26.00	3.38	1.06	1.13
Percentage increase English over Branch grass ration,	**5.00**	**5.80**	**7.00**	

It is evident that the cows made but little better use of the branch grass than did the sheep. Making the calculation explained under black grass, we find it to be 24 per cent less valuable than English hay. If the variation in live weight could also be brought into the calculation there would be a still greater difference. Sheep showed a 32 per cent difference. We are confident, however, that had the branch grass been in as good condition as the fox grass, it would have produced equally good results.

COST OF MILK AND BUTTER.

	Milk per quart.	Butter per pound.
Branch grass,	1.45cts.	14.50cts
English hay,	1.64cts.	16.12cts
Percentage increased cost with English hay ration,	**+11.6**	**+10.00**

Experiment IV.

Red top variety vs. English hay. Average results with 4 cows for 14 days. This hay was very dry, but woody and tasteless, and the animals showed no particular relish for it. They consumed however their entire daily ration.

AVERAGE DAILY RATION PER COW. (lbs.)

Ration.	Red top.	English hay.	Corn ensilage.	Wheat bran.	Chicago gluten meal.
Red top,	11	—	26.25	5	2.62
English hay,	—	10	26.25	5	2.62

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* In figuring these rations, the coefficients of digestibility obtained with sheep on branch grass were employed, hence the noticeably less amount of total digestible matter in the branch grass ration.

It was an error to feed a pound more of the red top than of the English hay in this ration, for the former was fully as dry as the latter. The error was not noticed till too late to rectify it. The advantage is therefore with the red top ration.

AVERAGE DRY AND DIGESTIBLE MATTER IN DAILY RATION. (lbs.)

Ration.	Total dry matter.	Protein.	Carbo-hydrates.	Fat.	Total digestible.	Nutritive ratio.
Red top,	21.95	2.05	10.54	.55	13.14	5.7
English hay,	21.27	2.16	10.84	.56	13.57	5.6

TOTAL GAIN OR LOSS IN LIVE WEIGHT.

Red top ration,	+13
English hay ration,	+13

AVERAGE MILK AND BUTTER YIELD PER COW DAILY. (lbs.)

Ration.	Milk.	Milk solids.	Milk fat.	Butter equivalent.
Red top,	15.90	2.40	.86	1.00
English hay,	17.46	2.61	.95	1.07
Percentage increase English over Red top ration,	**8.83**	**8.05**	**9.50**	—

Calculated as in previous cases, this hay shows 24 per cent less value than English hay. Digestion tests showed 17 per cent less value.

COST OF MILK AND BUTTER.

Ration.	Milk per quart.	Butter per pound.
Red top,	2.23 cents	16.50 cents
English hay,	2.46 "	18.60 "
Percentage increased cost with English hay ration,	**9.3**	**11.2**

EXPERIMENT V.

Cove mixture vs. English hay. Average results of six cows for 17 days. As previously stated, this salt hay consisted of a mixture of black grass and red top variety.

AVERAGE DAILY RATION PER COW DAILY. (lbs.)

Ration.	Mixture.	English hay.	Corn ensilage.	Wheat bran.	Chicago gluten meal.
"Mixture,"	11.17	—	27.00	5.	2.6
English hay,	—	10.17	26.42	5.	2.6

AVERAGE DRY AND DIGESTIBLE MATTER IN DAILY RATION. (lbs.)

Ration.	Total dry matter.	Protein.	Carbo-hydrates.	Fat.	Total digestible matter.	Nutritive ratio.
"Mixture,"	24.60	2.13	10.75	.54	13.42	5.6
English hay,	21.42	2.09	10.94	.54	13.57	5.8

TOTAL GAIN OR LOSS IN LIVE WEIGHT OF ANIMALS. (lbs.)

Mixture,	+14
English hay,	+55

The cows made quite a noticeable gain on the English hay ration.

AVERAGE MILK AND BUTTER YIELD PER COW DAILY. (lbs.)

Ration.	Milk.	Milk solids.	Milk fat.	Butter.
"Mixture,"	18.71	2.64	.93	1.08
English hay,	19.35	2.73	.92	1.07
Percentage increase English over "mixture,"	**3.34**	**3.44**	—	—

The influence of the black grass—a different sample from the one previously reported on—is quite apparent. The ration containing the cove hay mixture returns nearly as good results as the English hay ration. Figured in the usual way, a ton of the mixture would be worth about 8 per cent less than a ton of English hay. This agrees with results returned by the sheep.

COST OF MILK AND BUTTER.

Ration.	Quart milk.	Pound butter.
"Mixture,"	1.91 cents	15.40 cents
English hay,	2.23 "	18.60 "
Percentage increased cost with English hay ration,	**14.**	**18.**

Experiment VI.

Salt hay mixture vs. English hay. Average results with 4 cows for 14 days. This was the last hay fed, the period extending into May and June.

AVERAGE DAILY RATION PER COW. (lbs.)

Ration.	Salt mixture.	English hay.	Corn ensilage.	Wheat bran.	Chicago gluten meal.
Salt mixture,	10.75	—	30	5	2.5
English hay,	—	9.75	30	5	2.5

AVERAGE DRY AND DIGESTIBLE MATTER IN DAILY RATION. (lbs.)

Ration.	Total dry matter.	Protein.	Carbo-hydrates.	Fat.	Total digestible.	Nutritive ratio.
Salt mixture,	22.09	2.01	10.90	.54	13.45	6.0
English hay,	21.75	2.16	11.19	.57	13.92	5.8

TOTAL GAIN OR LOSS IN LIVE WEIGHT OF ANIMALS. (lbs.)

Salt mixture,	—4
English hay,	—9

The cows held about steady in live weight during this experiment, and one would naturally expect to notice the full effect of the food in the milk and butter yield. Had each half of this experiment extended over 28 days instead of 14, we should consider the results more satisfactory.

AVERAGE MILK AND BUTTER YIELD PER COW DAILY. (lbs.)

Ration.	Milk.	Milk solids.	Milk fat.	Butter equivalent.
Salt mixture,	23.0	3.03	1.00	1.17
English hay,	23.4	3.13	1.03	1.20
Percentage increased yield with English hay ration,	**1.7**	**2.6**	**2.9**	

Our calculation, as explained under black grass, would show this hay to have pound for pound of dry matter, 6 per cent less value than English hay, while the results with sheep show 14 per cent less value. Probably an average of 10 per cent less would not be far out of the way.

COST OF MILK AND BUTTER.

Ration.	Quart milk.	Pound butter.
Salt mixture,	1.58	14.45
English hay,	1.86	16.86
Percentage increased cost with Eng. hay ration,	**15.**	**14.2**

AVERAGE RESULTS OF ALL MILK EXPERIMENTS.

Excluding the Red top variety, which is not strictly speaking a salt hay, the *average results* of the other five tests are presented below.

AVERAGE DAILY RATION PER COW. (lbs.)

Ration.	Salt hay.	English hay.	Corn ensilage.	Wheat bran.	Chicago gluten meal.
Salt hay,	11.50	—	27.66	5	2.6
English hay,	—	10.54	28.12	5	2.6

AVERAGE DRY AND DIGESTIBLE MATTER IN DAILY RATIONS. (lbs.)

Ration.	Total dry matter.	Protein.	Carbohydrates.	Fat.	Total digestible.
Salt hay,	22.12	2.16	10.65	.55	13.36
English hay,	21.91	2.14	11.26	.56	13.96

TOTAL GAIN OR LOSS IN LIVE WEIGHT.

Sweet hay ration,	+3 pounds
English hay ration,	+147 "

TOTAL MILK AND BUTTER PRODUCED. (lbs.)

Ration.	Number of animals.	Number of days.	Milk.	Milk solids.	Butter.
Salt hay,	27	94	11361	1523	499.6
English hay,	27	94	11778	1585	521.8
Percentage increase with English hay ration,			**3.54**	**3.91**	**4.25**

COST OF MILK AND BUTTER.*

Ration.	Milk per quart.	Butter per pound.
Salt hay,	1.66 cents	15 cents
English hay,	1.96 “	17.53 “
Percentage cost with Eng. hay ration,	**15**	**15**

General remarks on results of milk experiments: If these experiments were to be repeated, we would make each feeding experiment six weeks long, for the reason that, in all probability, differences in feed effects would be more fully brought out by the longer time.

There is no *particular way* to feed salt hay in order to secure extra results. It is a coarse fodder, of the same general character and type of composition as English hay. Milch cows fed upon it exclusively would yield but small returns. It would hardly be advisable to make it the only source of roughage, because of its excess of salt, and because animals would tire of it sooner than of English hay. It cannot of course take the place of the more digestible and highly nitrogenous (protein rich) grain ration. It must therefore be fed as a partial substitute for some other coarse fodder. Half salt hay and half English hay, pea and oat hay, or cut corn stover would do very well as a daily coarse fodder ration, but 12 pounds of salt hay together with a bushel of corn ensilage for animals of average size is to be preferred, because of variety, palatability, and economy.

Salt hays contain three-fourths as much fertility as English hay, and our results would therefore confirm the general practice of making English hay a money crop, and feeding salt hay in its place. To get the best returns from salt hay, it must be fed in the neighborhood where it is produced, because of cost of transportation.

Farmers along the coast ought to grow more corn for the silo. A combination of corn ensilage, salt hay and seven to eight pounds of grain daily, makes one of the very cheapest of milk producing rations.

We have had no experience in feeding salt hay to horses, but our estimation of its value would apply to all animals of the farm.

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* For summary of all results see first pages of this bulletin.

F. EFFECT OF SALT MARSH HAY ON THE FLAVOR OF MILK AND BUTTER.

It is claimed by some who feed salt hay that it is apt to impart a salt taste to the milk. In order to test the correctness of this assertion, the following experiment was carried out, during the months of March and April. In the herd of 12 cows each was fed 5 pounds of wheat bran, 2½ pounds of Chicago gluten meal, 2 pounds of corn meal, and good first cut hay *ad libitum*. After a week had elapsed, the cream obtained from the milk produced in the eighth, ninth and tenth days was churned in three successive churnings. This may be called the first or English hay period.

In the second or salt hay period, twelve pounds of black grass were substituted in place of a like quantity of English hay. In the third experiment, twelve pounds of fox grass were fed in place of the English hay. After a lapse of seven days after feeding each variety of salt hay, three lots of butter were made under exactly the same conditions as in the English hay period. Every precaution was taken to have the milk perfectly clean. The barn was kept free from manure and well aired, the cows brushed before milking, and the milk removed to the dairy room as soon as drawn, and cooled by being at once immersed in ice water. Nine of the twelve cows had been in milk from 6 to 10 months, and the remainder about 3 months.

Mr. F. W. Mossman, employed at this station, made the butter, and presents the following data: The cream raised by the Cooley system was brought to 65° Fahr. in the ripening vat. Towards the end of the natural ripening, which required about 24 hours, the temperature was allowed to fall somewhat below the churning temperature, in one instance as low as 58° Fahr. The acidity was carefully noted during the ripening and found to range from .64 to .745 per cent of acid. The churning temperature at finish was from 58 to 65 degrees, and the butter came in from 20 to 35 minutes. The churn was stopped when the globules were about the size of wheat kernels, and the buttermilk drawn. One brine washing only was given, consisting of a quantity equal in volume to the estimated quantity of butter in the churn. After adding the brine, (at 53 to 56 degrees) the barrel churn was merely turned slowly three or four times, the brine then being withdrawn, the butter removed to a bowl, weighed, and turned upon a Mason worker. Salt at the rate of one ounce to the pound was then sifted evenly over the butter and the latter worked sufficiently to incorporate the salt, returned to the bowl and set away over night at a temperature of 60 degrees. The working was completed the following day with the aid of a small hand worker.

Samples of each lot of butter were sent to Mr. O Douglas of Boston, who together with other parties scored them as follows:

BUTTER SCORES.

	Standard.	English hay period.			Black grass (salt) period.			Fox grass (salt) period.		
		Samples:			Samples:			Samples:		
		I.	II.	III.	I.	II.	III	I.	II.	III.
Flavor,	50.	47.5	47	48	44	47	47	48 5	49	47
Grain,	25	25.	25	25	25	25	25	25.	25	25
Salt,	10.	10.	10	10	10	10	10	10.	10	10
Color,	10.	10.	10	10	10	10	10	10.	10	10
General appearance,	5.	5.	5	5	5	5	5	5.	5	5
Total,	100.	97.5	98	98	94	97	97	98.5	99	97

Mr. Douglas commented as follows on the butter received from the third or fox grass period: "I scored this butter myself, and had several good judges score after me, and the majority decided in favor of II as the best of the three samples. "You must have had some new milch cows to have been able to make any such butter at this season of the year."

Samples of the milk were submitted to three different parties, who were instructed to pay particular attention to any objectionable flavor. They reported that none could be detected.

These experiments make clear that the salt hays, when constituting from 30 to 40 per cent of the daily ration, did not impart any objectionable odor or flavor to the milk or butter. Flat sage is known to have a somewhat stronger flavor, and had that been fed, it is possible that the results might have been somewhat different. Had the entire coarse fodder ration consisted of salt hay, or had the hay been fed an hour previous to milking, it might have imparted its flavor to the butter or milk. While no one will deny that certain feed stuffs are liable to impair the natural flavor of dairy products. the above experiment serves to illustrate what can be accomplished by using proper precautions in feeding, and by the application of scientific principles in the care and manipulation of the resulting product. It is highly probable that most bad flavors get into milk and butter outside, rather than inside of the cow.

G. THE EFFECT OF SALT HAYS ON THE COMPOSITION OF MILK.

COMPOSITION OF THE MIXED MILK.

Experiment.	Number of cows.	Periods:	Total solids. Per cent.	Milk fat. Per cent.	Solids not fat. Per cent.
I.	6	Black grass	14.02	4.88	9.14
	6	English hay	14.13	4.87	9.16
II.	5	Fox grass	12.97	4.02	8.95
	5	English hay	12.89	4.14	8.75
III.	6	Branch grass	12.94	3.99	8.95
	6	English hay	13.01	4.06	8.95
IV.	4	Red top var.	15.09	5.40	9.69
	4	English hay.	15.01	5.44	9.57
V.	6	Cove mixture	14.11	4.95	9.16
	6	English hay	14.12	4.75	9.37
VI.	4	Salt mixture	13.23	4.37	8.86
	4	English hay	13.34	4.41	8.93

In experiment I, the fat and total solids show a slight increase in the English hay period, the increase in total solids being due to the increase in the percentage of fat. In experiment II the fat percentage is also slightly higher in the English hay period, while the solids not fat are lower. The fat increased at the expense of the other ingredients. In experiment III the total solids and fat show a slight increase in the English hay period, the total solids increasing because of the actual increase in the fat percentage. Experiment IV shows very slight variations. Experiment V shows a noticeable decrease in the fat percentage in the English hay period and a corresponding increase in the percentage of solids not fat. In experiment VI a slight increase is noted in the English hay period, in both fat and solids not fat.

H. DETAILED DATA OF EXPERIMENTS. EXPERIMENT I.

TABLE I.

Dates of Experiment I.	Periods and cows:	
	Black grass.	English hay.
Dec. 30th through Jan. 19th.	Beauty, Red, Pansy.	Mary, Jennie, Nora.
Jan. 27th through Feb. 16th.	Mary, Jennie, Nora.	Beauty, Red, Pansy.

TABLE II.

FEED CONSUMED DAILY.

Periods.	Cows:	Black grass.	English hay. Pounds.	Corn ensilage. Pounds.	Wheat bran. Pounds.	Chicago gluten meal. Pounds.
Black grass.	Mary,	13	—	19.50	5	2.5
	Jennie,	13	—	20	5	2.5
	Nora,	13	—	20	5	2.5
	Beauty,	14	—	25	5	3
	Red,	12	—	30	5	3
	Pansy,	11.6	—	20	5	2.5
English hay.	Mary,	—	12	20	5	2.5
	Jennie,	—	12	20	5	2.5
	Nora,	—	12	20	5	2.5
	Beauty.	—	13	25	5	3
	Red,	—	11	30	5	3
	Pansy,	—	11	20	5	2.5
Average black grass,		12.77		22.42	5	2.67
Average English hay,			11.83	22.50	5	2.67

TABLE III.

DRY AND DIGESTIBLE ORGANIC MATTER, CONSUMED DAILY.

Periods:	Cows.	Total dry matter.	Digestible.				Nutritive ratio.
			Protein. N. x 6.25.	Carbohydrates.	Fat.	Total.	
Black grass.	Mary,	21.84	2.15	10.18	.53	12.86	1 : 5.3
	Jennie,	21.84	2.15	10.18	.53	12.86	1 : 5.3
	Nora,	21.84	2.15	10.18	.53	12.86	1 : 5.3
	Beauty,	24.21	2.41	11.41	.59	14.41	1 : 5.3
	Red,	23.61	2.38	11.41	.60	14.39	1 : 5.3
	Pansy,	20.66	2.09	9.65	.51	12.25	1 : 5.1
English hay.	Mary,	21.36	2.06	10.81	.52	13.39	1 : 5.8
	Jennie,	21.36	2.06	10.81	.52	13.39	1 : 5.8
	Nora,	21.36	2.06	10.81	.52	13.39	1 : 5.8
	Beauty,	23.76	2.32	12.13	.58	15.03	1 : 5.8
	Red,	23.10	2.30	11.96	.59	14.85	1 : 5.7
	Pansy	20.49	2.03	10.38	.51	12.92	1 : 5.8
Average black grass,		22.23	2.22	10.50	.55	13.27	1 : 5.3
Average English hay,		21.90	2.14	11.15	.54	13.83	1 : 5.8

TABLE IV.

Total yields.

Periods: 21 days each.	Cows:	Milk. Pounds.	Milk solids. Pounds.	Milk fat. Pounds.	Butter. Pounds.
Black grass.	Mary,	389.18	55.38	18.68	21.79
	Jennie,	392.46	61.06	22.68	26.46
	Nora,	416.91	55.40	19.76	20.72
	Beauty,	413.02	58.64	21.02	24.52
	Red,	423.69	53.84	18.04	21.05
	Pansy,	422.18	60.12	21.82	25.46
	Total yields,	2457.44	344.44	120.00	140.00
English hay.	Mary,	430.07	61.71	21.93	25.59
	Jennie,	416.10	65.16	24.75	28.87
	Nora,	410.83	54.92	18.03	21.04
	Beauty,	433.23	61.99	21.57	25.16
	Red,	433.60	55.63	18.34	21.40
	Pansy,	447.23	64.04	23.12	26.97
	Total yields,	2571.06	363.44	127.74	149.03
Average daily yield black grass,		19.50	2.73	.95	1.11
Average daily yield English hay,		20.40	2.88	1.01	1.18
Percentage increase English over black.		4.40	5.24	6.06	—

TABLE V.

Weight of animals at beginning and end of experiment. (pounds.)

Periods:	Weight at:	Mary.	Jennie.	Nora.	Beauty.	Red.	Spot.	Total gain or loss.
Black grass.	Beginning,	809	882	821	998	1097	817	—28
	End,	804	873	825	995	1098	801	
English hay.	Beginning,	800	865	805	977	1093	788	+18
	End,	807	864	814	984	1085	792	

Experimeet II.

TABLE VI.

Dates of Experiment II.	Periods and cows:	
	Fox grass.	English hay.
Dec. 9th through Dec. 29th.	Roan, Bessie,	Daisy, Ruth, Mildred.
Jan. 11th through Jan. 31st.	Daisy, Ruth, Mildred.	Roan, Bessie.

TABLE VII.

Feeds consumed daily.

Periods:	Cows:	Fox grass. Pounds.	English hay Pounds.	Corn ensilage. Pounds.	Wheat bran. Pounds.	Chicago gluten.
Fox grass,	Daisy,	12.6	—	20	5	2.5
	Ruth,	13.	—	30	5	3.0
	Roan,	12	—	30	5	3.0
	Bessie,	12	—	30	5	3.0
	Mildred,	13	—	30	5	3.0
English hay.	Daisy,	—	12	20	5	2.5
	Ruth,	—	12	30	5	3.0
	Roan,	—	11	30	5	3.0
	Bessie,	—	11	30	5	3.0
	Mildred,	—	12	30	5	3.0
Average fox grass,		12.5	—	28	5	2.9
Average English hay,		—	11.6	28	5	2.9

TABLE VIII.

Dry and digestible organic matter consumed daily.

Periods:	Cows:	Total dry matter.	Digestible.				Nutritive ratio.
			Protein. N. x 6.25	Carbo-hydrates.	Fat.	Total.	
Fox grass.	Daisy,	21.37	2.18	10.24	.50	12.92	1 : 5.2
	Ruth,	24.32	2.47	11.96	.58	15.01	1 : 5.3
	Roan,	23.49	2.42	11.59	.58	14.59	1 : 5.4
	Bessie,	23.49	2.42	11.59	.58	14.59	1 : 5.4
	Mildred,	24.32	2.47	11.96	.58	15.01	1 : 5.3
English hay.	Daisy,	21.36	2.06	10.81	.53	13.40	1 : 6
	Ruth,	23.97	2.33	12.39	.60	15.31	1 : 6
	Roan,	23.10	2.30	11.96	.59	14.85	1 : 6
	Bessie,	23.10	2.30	11.96	.59	14.85	1 : 6
	Mildred,	23.97	2.33	12.39	.60	15.32	1 : 6
Average fox grass,		23.40	2.39	11.47	.56	14.42	1 : 5.3
Average English hay,		23.10	2.26	11.90	.58	14.75	1 : 6.0

TABLE IX.

TOTAL YIELDS.

Periods: 21 days each.	Cows:	Milk. Pounds.	Milk solids. Pounds.	Milk fat. Pounds.	Butter equivalent. Pounds.
Fox grass.	Daisy,	436.31	55.93	17.01	19.84
	Ruth,	377.88	51.88	17.11	19.96
	Roan,	542.32	71.37	21.96	25.62
	Bessie,	603.68	78.78	25.11	29.30
	Mildred,	645.04	79.92	23.73	27.68
	Total yield,	2605.23	337.88	104.92	122.40
English hay.	Daisy,	427.86	55.10	17.20	20.07
	Ruth,	392.53	51.45	15.89	18.54
	Roan,	558.49	73 94	23.00	26.84
	Bessie,	626.00	81.06	27.85	32.49
	Mildred,	642.81	79.96	25.52	29.77
	Total yield,	2647 69	341.51	109.46	127.71
Average daily yield fox grass,		24.8	3.22	1.00	1.16
Average daily yield English hay,		25.2	3.25	1.04	1.21
Percentage increase English over fox grass,		1.6	1.07	4.10	

TABLE X.

WEIGHT OF ANIMALS AT BEGINNING AND END OF EXPERIMENT (POUNDS).

Periods.	Weight at:	Cows:						Total gain or loss.
		Daisy.	Ruth.	Roan.	—	Bessie.	Mildred	
Fox grass.	Beginning,	770	965	858	—	823	834	+25
	End,	796	972	874	—	824	809	
English hay.	Beginning,	775	915	900	—	831	801	+39
	End,	787	948	881	—	832	813	

EXPERIMENT III.

TABLE XI.

Dates of Experiment III.	Periods and cows:	
	Branch grass.	English hay.
Feb. 13th through Mar. 5th.	Roan, Black, Mildred.	Daisy, Midget, Bessie.
Mar. 11 through Mar. 31st.	Daisy, Midget, Bessie.	Roan, Black, Mildred.

TABLE XII.

FEEDS CONSUMED DAILY.

Periods:	Cows:	Branch grass. Pounds.	English hay. Pounds.	Corn ensilage. Pounds.	Wheat bran. Pounds.	Chicago gluten. Pounds.
Branch grass.	Daisy,	10	—	20	5	2.0
	Midget,	10	—	30	5	2.5
	Roan,	10	—	35	5	2.5
	Black,	10	—	30	5	2.0
	Bessie,	11	—	35	5	2.5
	Mildred,	11	—	35	5	2.5
English hay.	Daisy,	—	9	19	5	2.0
	Midget,	—	9	30	5	2.5
	Roan,	—	9	35	5	2.5
	Black,	—	9	30	5	2.0
	Bessie,	—	10	35	5	2.5
	Mildred,	—	10	35	5	2.5
Average branch grass,		10.33	—	30.83	5	2.33
Average English hay,		—	9.33	30.67	5	2.33

TABLE XIII.

DRY AND DIGESTIBLE ORGANIC MATTER CONSUMED DAILY.

Periods:	Cows:	Total dry matter.	Digestible.				Nutritive ratio.
			Protein. N. x 6.25.	Carbo-hydrates.	Fat.	Total.	
Branch grass.	Daisy,	18.37	1.81	7.94	.46	10.21	1 : 5.0
	Midget,	20.97	2.08	9.52	.54	12.14	1 : 5.1
	Roan,	22.04	2.14	10.18	.57	12.89	1 : 5.3
	Black,	20.52	1.92	9.31	.51	11.74	1 : 5.5
	Bessie,	22.83	2.18	10.43	.58	13.19	1 : 5.4
	Mildred,	22.83	2.18	10.43	.58	13.19	1 : 5.4
English hay.	Daisy,	18.25	1.79	9.24	.47	11.50	1 : 5.7
	Midget,	21.07	2.09	10.96	.55	13.60	1 : 5.8
	Roan,	22.14	2.14	11.62	.58	14.34	1 : 6.1
	Black,	20.62	1.93	10.75	.52	13.20	1 : 6.2
	Bessie,	23.04	2.18	12.06	.59	14.83	1 : 6.0
	Mildred,	23.04	2.18	12.06	.59	14.83	1 : 6.0
Average branch grass,		21.26	2.05	9.64	54.	12.23	1 : 5.2
Average English hay,		21.36	2.05	11.11	.55	13.72	1 : 6.0

TABLE XIV.

TOTAL YIELDS.

Periods:	Cows:	Milk. Pounds.	Milk solids. Pounds.	Milk fat. Pounds.	Butter equivalent. Pounds.
Branch grass.	Daisy,	366.27	47.28	14.46	16.87
	Midget,	551.51	70.86	21.78	25.41
	Roan,	529.50	70.36	20.80	24.43
	Black,	523.90	69.57	22.63	26.40
	Bessie,	538.64	70.07	22.51	26.26
	Mildred,	596.49	73.84	21.59	25.19
	Total yield,	3106.31	401.98	123.77	144.56
English hay.	Daisy,	385.16	50.07	15.67	18.28
	Midget,	637.19	81.17	24.72	28.84
	Roan,	545.50	73.04	21.93	25.58
	Black,	492.81	66.18	22.07	25.75
	Bessie,	618.29	80.37	26.27	30.65
	Mildred,	597.94	75.57	22.42	26.16
	Total yield,	3276.89	426.40	133.08	155.26
Average daily yield branch grass,		24.7	3.19	.98	1.15
Average daily yield English hay,		26.0	3.38	1.06	1.23
Percentage increase English over branch grass,		5.2	5.8	7.00	

TABLE XV.

WEIGHTS OF ANIMALS AT BEGINNING AND END OF EXPERIMENT (POUNDS).

Periods:	Weight at:	Cows:						Total gain or loss.
		Daisy.	Midget.	Roan.	Black.	Bessie	Mildred	
Branch Grass.	Beginning,	747	742	876	864	847	809	—10
	End,	751	751	873	944	854	802	
English hay.	Beginning,	765	733	870	829	839	810	+44
	End,	744	732	891	840	843	840	

EXPERIMENT IV.

TABLE XVI.

Dates of Experiment IV.	Periods and cows:	
	Red top variety.	English hay.
May 8th through May 21st.	Beauty, Pansy.	Mary, Jennie.
May 27th through June 9th.	Mary, Jennie.	Beauty, Pansy.

TABLE XVII.

FEEDS CONSUMED DAILY.

Periods:	Cows:	Branch grass. Pounds.	English hay. Pounds.	Corn ensilage. Pounds.	Wheat bran. Pounds.	Chicago gluten. Pounds.
Red top variety.	Mary,	11	—	25	5	2.5
	Jennie,	11	—	25	5	2.5
	Beauty,	12	—	30	5	3.
	Pansy,	10	—	25	5	2.5
English hay,	Mary,	—	10	25	5	2.5
	Jennie,	—	10	25	5	2.5
	Beauty,	—	11	30	5	3.
	Pansy,	—	9	25	5	2.5
Average red top,		11	—	26.25	5	2.62
Average English hay,		—	10	26.25	5	2.62

TABLE XVIII.

DRY, AND DIGESTIBLE ORGANIC MATTER CONSUMED DAILY.

Periods:	Cows:	Total dry matter.	Digestible.				Nutritive ratio.
			Protein. N. x 9.25.	Carbo-hydrates.	Fat.	Total.	
Red top variety.	Mary,	21.56	2.00	10.31	.53	12.84	1 : 5.75
	Jennie,	21.56	2.00	10.31	.53	12.84	1 : 5.75
	Beauty,	23.97	2.22	11.54	.63	14.39	1 : 5.8
	Pansy,	20.69	1.96	9.93	.53	12.41	1 : 5.6
English hay.	Mary,	20.89	2.11	10.64	.54	13.29	1 : 5.6
	Jennie,	20.89	2.11	10.64	.54	13.29	1 : 5.6
	Beauty,	23.32	2.36	11.88	.64	14.88	1 : 5.7
	Pansy,	20.00	2.07	10.21	.53	12.81	1 : 5.5
Average fox grass,		21.95	2.05	10.52	.55	13.12	1 : 5.7
Average English hay,		21.27	2.16	10.84	.56	13.57	1 : 5.6

TABLE XIX.

Total yields.

Periods:	Cows:	Milk. Pounds.	Milk solids. Pounds.	Milk fat. Pounds.	Butter. Pounds.
Red top variety.	Mary,	203.07	30.37	10.86	12.67
	Jennie,	196.93	32.00	11.42	13.32
	Beauty,	244.38	36.75	13.31	15.53
	Pansy,	245.78	35.22	12.46	14.54
	Total yield,	890.16	134.34	48.05	56.06
English hay.	Mary,	249.80	36.59	13.04	15.21
	Jennie,	257.12	39.93	14.19	14.55
	Beauty,	226.83	34.59	12.81	14.94
	Pansy,	244.00	35.69	13.17	15.36
	Total yield,	977.75	146.80	53.21	60.06
Average daily yield red top,		15.90	2.40	.86	1.00
Average daily yield English hay,		17.46	2.61	.95	1.07
Percentage increase English hay over red top,		8.96	8.48	9.69	

TABLE XX.

Weight of animals at beginning and end of experiment (pounds).

Periods:	Weight at:	Cows:				Total gain or loss.
		Mary.	Jennie.	Beauty.	Pansy.	
Red top variety.	Beginning,	841	886	1061	834	+13
	End,	853	901	1051	830	
English hay.	Beginning,	820	869	1066	833	+13
	End,	833	870	1072	826	

Experiment V.

TABLE XXI.

Dates of Experiment V.	Periods and cows:	
	Cove mixture.	English hay.
Feb. 22d, through Mar. 10th.	Beauty, Red, Pansy.	Mary, Jennie, Nora.
Mar. 16th through April 1st.	Mary, Jennie, Nora.	Beauty, Red, Pansy.

TABLE XXII.

FEED CONSUMED DAILY.

Periods.	Cows:	Black grass.	English hay. Pounds.	Corn ensilage. Pounds.	Wheat bran. Pounds.	Chicago gluten meal. Pounds.
Cove mixture.	Mary,	10	—	25	5	2.5
	Jennie,	11	—	25	5	2.5
	Nora,	11	—	25	5	2.5
	Beauty,	13	—	30	5	3
	Red,	11	—	30	5	2.5
	Pansy,	11	—	25	5	2.5
English hay.	Mary,	—	9	25	5	2.5
	Jennie,	—	10	25	5	2.5
	Nora,	—	10	25	5	2.5
	Beauty.	—	12	29	5	3
	Red,	—	10	29.5	5	2.5
	Pansy,	—	10	25	5	2.5
Average black grass,		11.17	10.17	27.00	5	2.6
Average English hay,				26.42	5	2.6

TABLE XXIII.

DRY, AND DIGESTIBLE ORGANIC MATTER CONSUMED DAILY.

Periods:	Cows:	Total dry matter.	Digestible.				Nutritive ratio.
			Protein. N. x 6.25.	Carbo-hydrates.	Fat.	Total.	
Cove mixture.	Mary,	20.19	2.04	10.06	.50	12.60	1 : 5.6
	Jennie,	21.01	2.07	10 44	.50	12.97	1 : 5.6
	Nora,	21.01	2.07	10.44	.50	12.97	1 : 5 6
	Beauty,	24.19	2.37	12.05	.58	15 00	1 : 5.6
	Red,	22.09	2.14	11.10	.54	13.78	1 : 5.7
	Pansy,	21.01	2.07	10.44	.50	12.97	1 : 5.6
English hay.	Mary,	20.00	2.00	10.24	.51	12.76	1 : 5.7
	Jennie,	20.89	2.04	10.66	.52	13.22	1 : 5.9
	Nora,	20.89	2.04	10.66	.54	13.22	1 : 5.9
	Beauty,	24.01	2.33	12.27	.63	15.23	1 : 6.0
	Red,	21.86	2.11	11.15	.56	13.82	1 : 5.9
	Pansy,	20.89	2.04	10.66	.52	13.22	1 : 5.7
Average "Mixture,"		21.60	2.13	10.75	.54	13.42	1 : 5.6
Average English Hay,		21.42	2.09	10.94	.54	13.58	1 : 5.8

TABLE XXIV.

Total yields.

Periods:	Cows:	Milk. Pounds.	Milk solids. Pounds.	Milk fat. Pounds.	Butter. Pounds.
Cove hay mixture.	Mary,	305 97	44.15	15.05	17.56
	Jennie,	296.82	45.59	17.21	20.08
	Nora,	312.19	42.76	13.58	15.84
	Beauty,	346.11	50.04	20.42	23.82
	Red,	311.55	39.91	12.46	14.54
	Pansy,	335.63	46.77	15.77	18.40
	Total yields,	1908.27	269.22	94.49	110·24
English hay.	Mary,	320.65	46.33	14.75	17.21
	Jennie,	336.53	51.69	18.34	21.40
	Nora,	329.44	43.98	13.67	15.95
	Beauty,	331.18	48.78	17.71	20.66
	Red,	328.76	42.31	13.80	16.10
	Pansy,	327.65	45.73	15.56	18.15
	Total yields,	1974.21	278.82	93.83	109.47
Average daily yield "mixture,"		18.71	2.64	.93	1.08
Average daily yield English hay,		19.35	2.73	.92	1.07
Percentage increase English over mixture,		3.34	3.44		

TABLE XXV.

Weight of animals at the beginning and end of experiment (pounds).

Periods.	Weight at:	Cows:						Total gain or loss.
		Mary.	Jennie.	Nora.	Beauty.	Red.	Pansy.	
Cove mixture	Beginning,	803	880	836	1008	1085	820	+14
	End,	805	883	846	1018	1078	816	
English hay.	Beginning,	782	857	808	1012	1070	805	+55
	End,	786	854	816	1034	1081	818	

Experiment VI.

TABLE XXVI.

Dates of Experiment VI.	Periods and cows:	
	Salt mixture.	English hay.
May 7th through May 20th.	Black, Bessie.	Guernsey, Midget.
May 26th through June 8th.	Guernsey, Midget.	Black Bessie.

TABLE XXVII.

Feeds consumed daily.

Periods:	Cows:	Salt mixture. Pounds.	English hay. Pounds.	Corn ensilage. Pounds.	Wheat bran. Pounds.	Chicago gluten. Pounds.
Salt mixture	Guernsey,	11	..	30	5	2.5
	Midget,	10	..	25	5	2.5
	Black,	11	..	30	5	2.5
	Bessie,	11	..	25	5	2.5
English hay.	Guernsey,	..	10	30	5	2.5
	Midget,	..	9	25	5	2.5
	Black,	..	10	30	5	2.5
	Bessie,	..	10	35	5	2.5
Average salt mixture,		10.75	..	30	5	2.5
Average English hay,		..	9.75	30	5	2.5

TABLE XXVIII.

Dry and digestible organic matter consumed daily.

Periods:	Cows:	Total dry matter.	Digestible.				Nutritive ratio.
			Protein. N. x 6.25.	Carbo-hydrates.	Fat.	Total.	
Salt Mixture	Guernsey,	22.31	2.02	10.99	.54	13.55	1 : 6.1
	Midget,	20.36	1.94	9.97	.50	12.41	1 : 5.6
	Black,	22.31	2.02	10.99	.54	13.55	1 : 6.1
	Bessie,	23.38	2.08	11.65	.57	14.30	1 : 6.2
English Hay.	Guernsey,	21.97	2.17	11.30	.57	14.04	1 : 5.8
	Midget,	20.00	2.07	10.22	.53	12.82	1 : 5.5
	Black,	21.97	2.17	11.30	.57	14.04	1 : 5.8
	Bessie,	23.04	2.23	11.96	.60	14.79	1 : 6.0
Average salt hay,		22.09	2.01	10.90	.54	13.45	1 : 6.0
Average English hay,		21.75	2.16	11.19	.56	13.92	1 : 5.8

TABLE XXIX.

TOTAL YIELDS.

Periods:	Cows:	Milk. Pounds.	Milk solids. Pounds.	Milk fat. Pounds.	Butter. Pounds.
Salt mixture	Guernsey,	326.35	44.05	15.17	17.70
	Midget,	303.63	39.83	12.35	14.41
	Black,	298.50	39.79	12.89	15.04
	Bessie,	356.33	46.28	15.67	18.28
	Total yield,	1284.81	169.95	56.08	65.43
English hay.	Gurnsey,	345.52	46.26	16.48	19.23
	Midget,	342.64	45 02	14.22	16.59
	Black,	274.77	37.95	12.50	14.58
	Bessie,	345.29	45.26	14.50	16.92
	Total yield,	1308.22	174.49	57.70	67.32
Average daily yield salt mixture,		23.00	3.03	1.00	1.17
Average daily yield English hay,		23.40	3.13	1.03	1.20
Percentage increase English over salt mixture,		1.7	2.60	2.88	—

TABLE XXX.

WEIGHT OF ANIMALS AT BEGINNING AND END OF EXPERIMENT. (pounds.)

Periods:	Weight at:	Cows:				Total gain or loss.
		Guernsey.	Midget.	Black.	Bessie.	
Salt mixture,	Beginning,	869	755	855	861	—4
	End,	863	750	858	865	
English hay.	Beginning,	858	750	863	862	—9
	End,	858	747	861	858	

I. General Data.

TABLE XXXI.

History of grade cows.

1896-97.

Name.	Grade.	Age.	Last calf dropped	Milk yields (lbs.) at beginning of experiment.					
				I.	II.	III.	IV.	V.	VI.
Mary,	Jersey,	9	July,	21	..	..	18	19	..
Jennie,	Jersey,	6	September,	19	..	..	18	20	..
Nora,	Jersey,	9	August,	20	..	..	..	20	..
Beauty,	Jersey,	7	September,	20	..	..	18	20	..
Red,	Durham,	8	August.	20	..	..	..	20	..
Pansy,	Jersey,	7	November,	21	..	..	18	20	..
Daisy,	Jersey,	9	September,	..	21	19	..	..	..
Guernsy,	Guernsey,	8	March,	..	..	..	..	..	25
Ruth,	Ayrshire,	8	June,	..	19	..	..	..	..
Midget,	Jersey,	5	January,	..	..	30	..	..	25
Black,	Jersey,	4	January,	..	..	25	..	..	21
Roan,	Durham,	7	October,	..	25	26	..	..	..
Bessie,	Ayrshire,	8	November,	..	29	29	..	..	26
Mildred,	Ayrshire,	7	October,	..	31	30	..	..	..

TABLE XXXII.

Total feed stuffs consumed during each experiment. (pounds.)

Experiment.	Periods:	Salt hay.	English hay.	Corn ensilage	Wheat bran.	Chicago gluten meal.
I.	Black grass,	1609	..	2835	630	336
	English hay,	..	1596	2835	630	336
II.	Fox grass,	1312	..	2940	525	304.5
	English hay,	..	1218	2940	525	304.5
III.	Branch grass,	1302	..	3885	630	294
	English hay.	..	1176	3868	630	294
IV.	Red top,	616	..	1470	280	147
	English hay,	..	560	1470	280	147
V.	Cove mixture,	1139	..	2754	510	265
	English hay,	..	1037	2693	510	265
VI.	Salt mixture,	602	..	1680	280	140
	English hay,	..	546	1680	280	140

TABLE XXXIII.

SHOWING TOTAL DRY AND DIGESTIBLE ORGANIC MATTER CONSUMED BY THE HERD DURING THE EXPERIMENTS, AND THE TOTAL MILK, MILK SOLIDS, AND MILK FAT PRODUCED.

Experiment.	Periods:	Dry matter.	Digestible matter.	Pounds milk.	Pounds solids.	Pounds fat.
I.	Black grass,	2813.6	1672	2457	344	120
	English hay,	2759.4	1742.6	2571	363	127.7
II.	Fox grass,	2457	1514	2605	338	105
	English hay,	2425.5	1548.7	2648	342	109.5
III.	Branch grass,	2678.7	1541	3106	402	124
	Englise hay,	2691.4	1728.7	3277	426	133.1
IV.	Red top,	1229.2	734.7	890	134.3	48
	English hay,	1191.I	759.9	978	146.8	53
V.	Cove mixture,	2203	1364.7	1908	269	94.5
	English hay,	2183	1385.2	1974	279	93.8
VI.	Salt mixture,	1237	753.2	1285	170	56.1
	English hay,	1218	779.5	1308	175	57.7
	*Total salt hays,	11389.3	6844.9	11361	1523	499.6
	*Total English hays,	11277.3	7184.7	11778	1585	521.8

*Excluding Experiment IV.

TABLE XXXIV.

POUNDS OF DRY MATTER AND OF DIGESTIBLE ORGANIC MATTER REQUIRED TO PRODUCE 100 POUNDS MILK, A POUND OF MILK SOLIDS, AND A POUND OF MILK FAT.

Experiment.	Periods:	Pounds required of:	To produce:		
			100 pounds milk.	One pound milk solids.	One pound milk fat.
I.	Black grass,	dry matter,	114.5	8.18	23.45
	English hay,	dry matter,	107.3	7.60	21.56
	Black grass,	digestible matter,	68.4	4.86	13.92
	English hay,	digestible matter,	67.7	4.80	13.61
II.	Fox grass,	dry matter,	94.3	7.27	23.40
	English hay,	dry matter,	91.6	7.09	22.15
	Fox grsss,	digestible matter,	58.1	4.48	14.42
	English hay,	digestible matter,	58.5	4.53	14.14
III.	Branch grass,	dry matter,	86.2	6.66	21.60
	English hay,	dry matter,	82.1	6.32	20.23
	Branch grass,	digestible matter,	49 6	3.83	12.43
	English hay,	digestible matter,	52.8	4.06	13.09
V.	Cove mixture,	dry matter,	115 4	8.19	23.31
	English hay,	dry matter,	110.6	7.82	23 27
	Cove mixture,	digestible matter,	69.3	5.07	14.44
	English hay,	digestible matter,	70.2	4.97	14.77
VI.	Salt mixture,	dry matter,	96.3	7.28	22.05
	English hay,	dry matter,	93.1	6 96	21.21
	Salt mixture.	digestible matter,	58 6	4 43	13.43
	English hay,	digestible matter,	59.6	4.46	13.51
	Average salt hay,	dry matter,	100 2	7.47	22.78
	Average English hay,	dry matter,	95 7	7.12	21 60
	Average salt hay,	digestible matter,	60.8	4 53	13.73
	Average English hay,	digestible matter,	61.8	4.56	13.81

TABLE XXXV.

AVERAGE COMPOSITION OF MILK.

Experiment:	Periods:	Mary.			Jennie.			Nora.			Beauty.			Red.			Pansy.		
		Total solids. Per cent.	Fat. Per cent.	Solids not fat. Per cent.	Total solids. Per cent.	Fat. Per cent.	Solids not fat. Per cent.	Total Solids. Per cent.	Fat. Per cent.	Solids not fat. Per cent.	Total solids. Per cent.	Fat. Per cent.	Solids not fat. Per cent.	Total solids. Per cent.	Fat. Per cent.	Solids not fat. Per cent.	Total solids. Per cent.	Fat. Per cent.	Solids not fat. Per cent.
I.	Black grass,	14.23	4.80	9.43	15.56	5.78	9.78	13.29	4.26	9.03	14.20	5.09	9.11	12.71	4.26	8.45	14.24	5.17	9.07
	English hay,	14.35	5.10	9.25	15.66	5.95	9.71	13.37	4.39	8.98	14.31	4.98	9.33	12.83	4.23	8.60	14.32	5.17	9.15
IV.	Red top,	14.96	5.35	9.61	16.25	5.80	10.45	..	..	..	15.04	5.45	9.60	..	..	..	14.33	5.07	9.26
	English hay,	14.65	5.22	9.42	15.53	5.52	10.01	..	..	..	15.25	5.65	9.61	..	..	..	14.63	5.40	9.23
V.	Cove mixture,	14.43	4.92	9.51	15.77	5.80	9.97	13.70	4.35	9.35	14.46	5.90	9.56	12.81	4.00	8.81	13.95	4.70	9.25
	English hay,	14.45	4.60	9.84	15.36	5.45	9.90	13.35	4.15	9.19	14.73	5.35	9.38	12.87	4.20	8.67	13.96	4.75	9.21
		Daisy.			Midget.			Roan.			Black.			Bessie.			Mildred.		
II.	Fox grass,	12.82	3.90	8.92	13.73	4.53	9.19	13.16	4.05	9.10	..	..	..	13.05	4.16	8.89	12.39	3.68	8.71
	English hay,	12.88	4.02	8.86	13.11	4.05	9.06	13.24	4.12	9.12	..	..	..	12.95	4.15	8.50	12.44	3.97	8.48
III.	Branch grass,	12.91	3.95	8.96	12.85	3.95	8.90	13.29	3.93	9.44	13.28	4.32	9.01	13.01	4.18	8.83	12.38	3.62	8.81
	English hay,	13.00	4.07	9.00	12.74	3.88	8.87	13.39	4.02	9.37	13.43	4.48	8.95	13.00	4.25	8.78	12.64	3.75	8.89
VI.	Salt mixture,	13.50	4.65	8.85	13.12	4.07	9.05	..	..	..	13.33	4.32	9.01	12.99	4.40	8.59	..	..	..
	English hay,	13.39	4.77	8.62	13.14	4.15	8.99	..	..	..	13.81	4.55	9.26	13.11	4.20	8.91	..	..	..

In making the calculations found in table XXXIV, it has been assumed that the animals remained constant in weight throughout all of the experiments. This however was not actually the case, as during the English hay periods, the animals gained 147 pounds, while during the salt hay period but 3 pounds increase were noted. If it were possible to calculate live weight into milk or milk ingredients, the above figures would make a slightly more favorable showing for the English hay periods. The facts brought out however are first, that rather more dry matter was required to produce milk and butter fat in the salt hay than in the English hay rations. The reason for this is to be found in the lower digestibility of the salt hay.

In the second place, it is to be noted that pound for pound of digestible material, practically equal amounts of milk, etc. were produced.

TABLE XXXVI.

COMPOSITION OF FEEDS.*

	Wheat bran.	Wheat bran.**	Corn ensilage.	Chicago gluten meal.
Water,	12.50	13.00	78.50	9.00
Protein,	16.26	16.61	1.82	34.00
Fat,	4.59	5.08	.63	6.68
Fiber,	10.89	9.59	6.18	3.25
Extract matter,	49.57	49.03	11.28	45.69
Ash,	6.19	6.69	1.59	1.38
	100.00	100.00	100.00	100.00

TABLE XXXVII.

COEFFICIENTS OF DIGESTIBILITY.

	Protein.	Fat.	Fiber.	Extract matter.
English hay,	54	40	58	56
Fox grass,	59	36	57	53
Black grass,	54	46	57	49
Branch grass,	52	37	25	46
Cove hay mixture,	48	40	60	53
Red top variety,	37	49	56	46
Salt mixture,	42	28	58	52
Corn ensilage,	65	52	77	79
Wheat bran,	79	68	22	69
Chicago gluten,	89	93	—	93

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* Composition of salt and English hay will be found under heading C.

** Used in Experiments IV and VI.

DRY MATTER DETERMINATIONS. (per cent)

The various feed stuffs showed very slight changes in moisture during the several experiments.

SALT HAYS.

Black grass.	Fox grass.	Branch grass.	Red top variety.	Cove mixture.	Salt mixture.
84	83	79	87	82	86

OTHER FEED STUFFS. (per cent)

English hay.	Corn ensilage.	Wheat bran.	Chicago gluten meal.
89*	21.50	87.50* *	91

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* In experiment I 88 per cent, and in experiment II 87 per cent.

* * In experiments IV and VI, 87 per cent.

NOTES.—In some copies of this bulletin, the top of page 19 reads, "and others from 8 to 12 per cent less," etc. It should read, "and others from 12 to 18 per cent less."

Page 27, under Cost of Milk and Butter, now reads "percentage cost with English hay ration." It should read "percentage increased cost with English hay ration."